

Practical Exam in Biology

בחינת בגרות מעשית בביולוגיה

Problem 1

בעיה 1

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

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Instructions for examinees:

הוראות לנבחן:

א. Duration of the exam: Three hours

א. משך הבחינה: שלוש שעות.

ב. Material that may be used during the exam:
Hebrew-foreign language / foreign language-
Hebrew dictionary

ב. חומר עזר מותר בשימוש:
מילון עברי-לועזי / לועזי-עברי

ג. Special instructions:

ג. הוראות מיוחדות:

- (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 that you obtained, even if they are not as expected.

- (1) קרא את ההנחיות ביסודיות ושקול היטב את צעדיך.
- (2) רשום בעט את כל תצפיותיך ותשובותיך (גם סרטוטים).
- (3) בסס את תשובותיך על תצפיותיך ועל התוצאות שקיבלת, גם אם הן אינן תואמות את הצפוי.

Write in the exam 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.

כתוב במחברת הבחינה בלבד. רשום "טיוטה" בראש כל עמוד המשמש טיוטה. כתיבת טיוטה בדפים שאינם במחברת הבחינה עלולה לגרום לפסילת הבחינה.

Good Luck!

בהצלחה!

Problem 1

In this problem, you will examine processes that take place in seeds and seedlings.

The questions in this exam are numbered **1-12**. The point value of each question is given on the left. Answer all of the questions in your notebook.

Part א — Examining (in the presence of tetrazolium) a process that occurs in cowpeas (black-eyed peas) [לוביה]

On your table are two test tubes labeled "טטרזוליום" [tetrazolium] and containing a colorless solution of a tetrazolium salt.

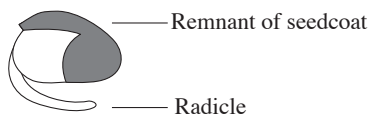
Informative Note 1: Tetrazolium is a substance that allows us to check whether cellular respiration is taking place.
In the presence of respiration process products, tetrazolium turns a pink-purple.

א. Put on the gloves that are on your table.

- Use a glass marking pen to write "נבטים" [seedlings] on one of the test tubes labeled "טטרזוליום" [tetrazolium], and write "מורתחים" [boiled] on the other test tube labeled "טטרזוליום".

On the table are two containers with seedlings that have been sprouted for 24 hours: one is labeled "נבטי לוביה" [cowpea seedlings] and the other, labeled "נבטי לוביה מורתחים" [boiled cowpea seedlings], contains cowpea seedlings that have been boiled for a few minutes. You are going to place seedlings in the labeled test tubes. You may use the tweezers, but avoid damaging the radicle [שורשן] area of the seedlings (see Figure 1).

Figure 1: Cowpea seedling



Note: Some of the seedlings still have a green seed coat [קליפת הזרע], and some have lost it.

The seed coat does not affect the process being examined, so you can use seedlings with or without a seed coat.

- ב. Transfer 5 seedlings from the "נבטי לוביה" container to the test tube labeled "נבטים – טטרזוליום", and transfer 5 seedlings from the container labeled "נבטי לוביה מורתחים" to the test tube labeled "טטרזוליום – מורתחים". Cap the test tubes.
- Close the seedling containers so that the seedlings do not dry out.
- ג. Put the two test tubes in the disposable cup on your table labeled "חלק א" [Part א].
- Write down the time: _____.
 - You must wait at least 45 minutes before checking the results. While you are waiting, perform Part ב.
 - You do not need to wear gloves for the following tasks, so take them off now and put them in a waste container.

Part ב — Monitoring the process that takes place in cowpea seeds and seedlings

On your table you have 4 closed test tubes. Each of the test tubes contains slaked lime [בסיס הסידן] powder ($\text{Ca}(\text{OH})_2$).

A wad of cotton wool has been placed on top of the powder. This separates the powder from the seeds or seedlings that will be placed in the test tube but still allows free passage of gases.

Informative Note 2: Slaked lime powder reacts with the gas carbon dioxide (CO_2) and a solid compound is obtained.

You have been given 3 containers with seeds or seedlings, as follows:

- a container labeled "זרעי לוביה יבשים" [dry cowpea seeds]
 - a container labeled "זרעי לוביה מותפחים" [swollen cowpeas]. These seeds were soaked in water for 12 hours before the experiment began; water has entered the seeds and they have swelled.
 - a container labeled "נבטי לוביה" [cowpea seedlings]
- ד. Use a glass marking pen to write "יבשים" [dry] on one of the test tubes containing slaked lime powder, "מותפחים" [swollen] on the second test tube, "נבטים" [seedlings] on the third test tube, and "בקרה" [control] on the fourth test tube.
- ה. Transfer 25 dry seeds to the test tube labeled "יבשים".
— Put the test tube back in the stand.
- ו. Repeat Item ה with 25 swollen seeds and the corresponding test tube.
- ז. Repeat Item ה with 25 seedlings and the corresponding test tube.
Do not add anything to the "בקרה" test tube.
- ח. Lay 3-4 paper towels on the table.
You have been given pipettes. Each pipette is attached to a stopper.
— Cap the test tube labeled "בקרה" using one of the stoppers attached to a pipette.
This is an **experiment set-up** [מערכת ניסוי] (see Figure 2).

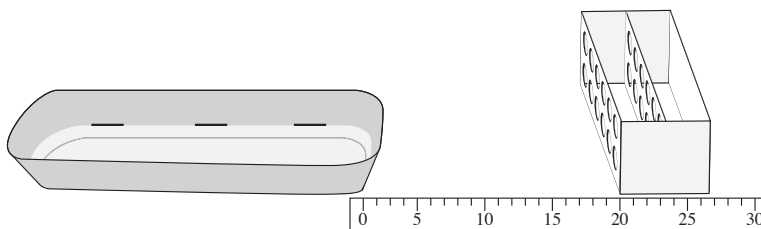
Figure 2: Experiment set-up



- Carefully tighten the stopper using a circular motion, and place the experiment set-up on the paper towels.

- ט. Cap the test tubes labeled "יבשים", "מותפחים", and "נבטים" so that you can prepare 3 more experiment set-ups according to the instructions in Item ח.
- י. You have a container labeled "מי ברז-חלק ב" [tap water for Part ב] and an aluminum pan. There are line markings on the inside wall of the pan.
- Pour tap water into the pan up to the marked lines.
- If the water is higher than the marked lines, use a disposable cup to remove some water, and pour it back into the container marked "מי ברז-חלק ב".
- Turn the test tube stand on its broad side and place it about 20 cm from the pan (see Figure 3.א).

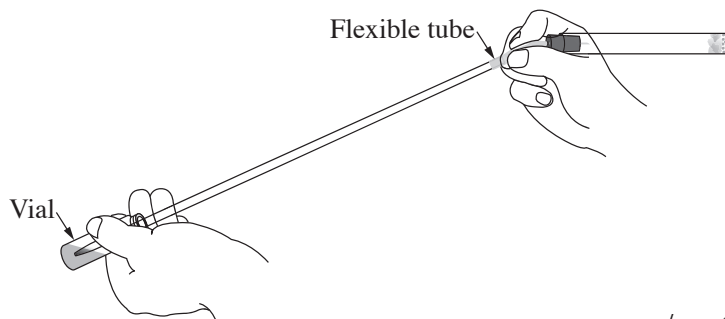
Figure 3.א: Position of the test tube stand and the pan



- יא. In this item you will start working with the experiment set-ups you prepared in Items ח and ט. **Before you continue the experiment, carefully read the instructions in this item and look at Figures 3.ב and 3.ג.**

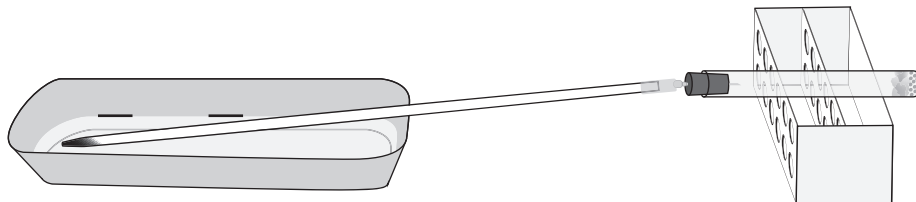
- You have a vial labeled "פנול אדום" [phenol red]. Uncap the vial.
 - Lift the "בקרה" experiment set-up with one hand, grasping the flexible tube with your fingers.
- Use the other hand to hold and tilt the vial of dye (see Figure 3.ב).
- Dip the tip of the pipette in the red liquid that is in the vial. Squeeze the flexible tube with your fingers and then let go.
- This will draw up some red liquid into the pipette.
- The red color of the liquid will make it easier for you to see the level of liquid in the pipette.

Figure 3.ב: Withdrawing red liquid



- Place the test tube across the broad side of the test tube stand, and lay the pipette diagonally in the pan so that the tip containing the red liquid is immersed in the water in the pan (see Figure 3.g).

Figure 3.g: Arrangement of the experiment set-up



- יב. Repeat Item יא with the other experiment set-ups, and place them next to each other alongside the "בקרה" set-up.

Note: The level of red liquid does not have to be equal in all the pipettes.

- Cap the phenol red vial.

- יג. Once the tips of all four pipettes are in the water, write down the time _____.
Wait 5 minutes for the experiment set-ups to stabilize.

- יד. 5 minutes after the time you recorded in Item יג, without moving the pipettes, draw a line with a glass marking pen to mark the level of the red liquid in each of the pipettes.

- Write down the time _____. This is the experiment's **start time**.

- טו. **Note:** Do not move the experiment set-ups or touch them for an additional 10 minutes, and do not re-tighten the stoppers.

After 10 minutes, mark a line again at the level of the red liquid in each of the pipettes, and use a ruler to measure the distance between the two lines.

- While you are waiting, read Informative Note 3 and answer Question 1 on the following page.

Informative Note 3:

- Each experiment set-up is a closed system in which a change in volume of the gases causes movement of the liquid in the pipette. When the volume of gases in the set-up decreases, the red liquid in the pipette moves toward the test tube stopper.
- The gas carbon dioxide (CO_2) does not affect the volume of gases in the system, because it reacts with the slaked lime at the bottom of the test tube and forms a solid compound whose volume is negligible.
- Changes in room temperature may affect the volume of gases in the system and cause the liquid to move.

Answer Question 1.

(14 points) 1. א. In **your notebook**, draw a table to summarize the experiment (with the 4 experiment set-ups) and the results.

(4 points) ב. Give the table in your notebook a title and suitable column headings.

ט. At least 10 minutes after the time you recorded in Item ז, mark the final level of the red liquid in each of the pipettes.

- Add a small circle at the end of the line so that you know this line marks the level of the red liquid at the end of the experiment. For example: ●——

Note: It is possible that in one (or more) of the set-ups the liquid moved back (away from the test tube stopper). Mark the final level of liquid in this case, too.

ז. Take the 4 test tubes with pipettes off the stand and put them on the paper towels on your table.

- For each pipette, use a ruler to measure the distance from the initial line (which you marked at the start time in Item ז) to the final line (which you marked in Item ט).
- Write the results of your measurements in the table in **your notebook**. If the liquid moved back (away from the test tube stopper), add "-" (minus) next to the result you recorded.

Answer Questions 2-5.

(5 points) 2. א. Explain why it was important to include a control set-up in this experiment.

(4 points) ב. Sometimes the red liquid moves forward (toward the test tube stopper) also in the "בקה" set-up.

In this case, the result obtained in this set-up should be deducted from the result obtained in each of the other experiment set-ups (Note: No need to actually do this).

Using Informative Note 3 explain why this result should be deducted.

(4 points) 3. א. What is the dependent variable that was measured in this experiment?

(3 points) ב. Explain how the way it was measured is appropriate for measuring the dependent variable.

(4 points) ג. Explain the effect of the biological process you measured in the "גבטים" experiment set-up on one of the processes that occur during seedling growth.

(4 points) 4. א. The percentage of water in dry seeds is very low. When the seeds were soaked, water entered the seeds and they swelled.

Use this fact to explain the results obtained in the "יבשים" experiment set-up and in the "מותפחים" experiment set-up.

(4 points) ב. In the winter, when temperatures in the fields are very low and there is frost, ice crystals form inside the seedling cells. These crystals damage the cell membranes. Use this fact to hypothesize how frost will affect seedling growth. Explain.

- (2 points) 5. א. List two factors that were kept constant in Part ב of the experiment (other than temperature).
- (3 points) ב. Choose one of these factors and explain why it was important to keep this factor constant.

Checking the results of Part א

- יח. At least 45 minutes after the time you recorded in Item ג, look at the seedlings that you soaked in tetrazolium solutions in the test tubes that were placed in the cup labeled "חלק א" (in Item ג). If there is no change in seedling color in any of the test tubes, wait a further 15 minutes until there is a change in color in one of the test tubes. While you are waiting you may answer Question 8.

After there is a change in seedling color in one of the two test tubes from Part א, answer Questions 6-8.

- (5 points) 6. א. What color are the seedlings in each of the two test tubes?
- (4 points) ב. Use the information in Informative Note 1 (page 2) to explain the results you obtained in each of the two test tubes.
7. The table below presents possible alternatives for the two parts of the experiment you conducted.

	Part א (Items ג-א, Item יח)	Part ב (Items יז-ד)
i	Qualitative experiment / Quantitative experiment	Qualitative experiment / Quantitative experiment
ii	Monitoring the reactant (starting material) in the process / Testing one of the process's products	Monitoring the reactant (starting material) in the process / Testing one of the process's products

- (4 points) א. (1) Use the information in Informative Note 1 and in Informative Note 3, and circle the correct alternatives in lines i-ii in each of the parts of the table above.
- (2) Draw the table in your notebook, and copy only the correct answers that you circled into the appropriate spaces in the table.
- (3 points) ב. Explain the alternatives you selected in line i of the table in your **notebook**.
8. The seedlings on your table were germinated in the dark.
- (3 points) א. Explain what allows the seedlings to develop without any light.
- (2 points) ב. Can the seedlings continue developing and growing without light? Explain.

Part ג — Analysis of experimental results: Effect of duration of storage on the viability of soy seeds

Seeds are the units of propagation [יחידות הריבוי] of plants. Inside the seed is an embryo which is the product of a fertilization process. After germination, the embryo develops into a new plant. A viable seed is a seed whose embryo is alive and which can germinate under suitable conditions. The Agricultural Research Organization in Israel has a "gene bank" where plant seeds are stored. These are seeds of wild plants with agricultural significance or of endangered [בסכנת הכחדה] rare plants. The gene-bank scientists routinely check the viability of the seeds so that it will be possible to plant them in the future. If the viability of seeds of a certain species decreases, the scientists germinate the seeds, grow them into plants, and then collect and store the fresh seeds.

Scientists were interested in testing the viability of soy seeds during storage.

Experiment 1:

The scientists stored the seeds at a temperature of 25°C. At certain intervals they took a sample of the stored seeds, germinated them, and 8 days later checked the percentage of germination. The results of their experiment are shown in Table 1.

Table 1

Seed storage time (months)	Germination percentage (percent)
0	95
3	85
6	80
9	75
12	70
18	65

- (3 points) **9. א.** What type of graphical representation is most suited to describing the results shown in Table 1, a continuous graph or a bar diagram? Explain your answer.
- (6 points) **ב.** **In your notebook**, use a suitable graphical representation to present the experimental results shown in Table 1.
- (5 points) **10. א.** Describe the results of the experiment, based on your graphical representation.
- (3 points) **ב.** Use the results to hypothesize the expected germination percentage of soy seeds stored under the same conditions for 24 months. Note: You do not need to specify an exact number. Explain your answer.

Some species of plants have seeds that only germinate in certain seasons or whose germination process is very long.

The scientists therefore tried another, faster, method of testing seed viability.

This method is described below.

A certain quantity of seeds is soaked in distilled water. After 24 hours, the electrical conductivity of the soaking solution is measured. The principle behind this method of measuring viability is that a solution that contains salts is electrically conductive. The higher the concentration of salts in the solution, the greater its electrical conductivity.

Experiment 2:

Scientists stored soy seeds at a temperature of 25°C. At certain intervals they took a sample of stored seeds, soaked them in distilled water, and measured the electrical conductivity of the soaking solution. When seeds contain dead cells or cells with damaged membranes, various substances, including salts, leak into the soaking solution.

The results of this experiment are shown in Table 2.

Table 2

Seed storage time (months)	Electrical conductivity of the soaking solution (relative units)
0	60
3	63
6	70
9	73
12	80
18	115

(5 points) **11. א.** Explain the percentage of germination results in Experiment 1, based on the measurements of electrical conductivity (Table 2).

(3 points) **ב.** Students soaked two groups of seedlings in distilled water: seedlings ("נבטים") and boiled seedlings ("נבטים מורתחים"), like the ones you investigated in the experiment in Part א.

In which soaking solution will electrical conductivity be higher, in the seedlings or boiled seedlings? Explain, using the results of your investigation in Part א (which you provided in answer to Question 6).

(Note: The next question is on the following page.)

/continued on page 10/

In 1963, an archeological dig was conducted in Metzada [מצדה] in the east Judean Desert. In the Judean Desert the humidity of the air and the soil are very low. In the dig, several date pits about 2000 years old were found. Scientists tried to germinate the seeds and one of them sprouted and developed into a palm tree (the tree has been named Metushelah after the oldest person in the Bible).

- (1 point) **12. א.** Explain what made it possible for the seed to germinate after so long. Base your answer on the conditions in the habitat in which the seed was preserved and on the results you obtained in Part ב of your experiment.
- (2 points) **ב.** Can the fact that only one of the seeds found in Metzada germinated be explained by the results of Experiment 1 shown on page 8? Explain.

Give the proctor your exam paper and your notebook.

Good Luck!

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בהצלחה!

זכות היוצרים שמורה למדינת ישראל.
אין להעתיק או לפרסם אלא ברשות משרד החינוך.

Practical Exam in Biology

בחינת בגרות מעשית בביולוגיה

Problem 2

בעיה 2

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

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Instructions for examinees:

הוראות לנבחן:

א. Duration of the exam: Three hours

א. משך הבחינה: שלוש שעות.

ב. Material that may be used during the exam:
Hebrew-foreign language / foreign language-
Hebrew dictionary

ב. חומר עזר מותר בשימוש:
מילון עברי-לועזי / לועזי-עברי

ג. Special instructions:

ג. הוראות מיוחדות:

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- (2) Write all of your observations and answers in pen (including sketches).
- (3) Base your answers on your observations and the results that you obtained, even if they are not as expected.

- (1) קרא את ההנחיות ביסודיות ושקול היטב את צעדיך.
- (2) רשום בעט את כל תצפיותיך ותשובותיך (גם סרטוטים).
- (3) בסס את תשובותיך על תצפיותיך ועל התוצאות שקיבלת, גם אם הן אינן תואמות את הצפוי.

Write in the exam 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!

Problem 2

In this problem, you will examine processes that take place in seeds and seedlings.

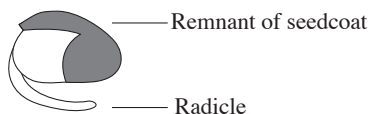
The questions in this exam are numbered **13-24**. The point value of each question is given on the left. Answer all of the questions in your notebook.

Part א — Examining a process that occurs in cowpea radicles (black-eyed peas) [לוביה]

On your table are two test tubes with agar.

Seedlings with radicles were placed in the test tube labeled "נבטים באגר" [seedlings in agar]. The agar contains a large amount of water, so the radicles continued to grow in it. The seedlings have not utilized any of the other substances in the agar.

Figure 1: Cowpea seedling



- א. You have a vial containing a solution of phenol red [פנול אדום]. Use the dropper to add 6 drops of phenol red to each of the two test tubes.

Transfer the two test tubes to the disposable cup on your table labeled "חלק א" [Part א].

Informative Note 1:

- Phenol red is an indicator [חומר בוחן]. In an alkaline environment it is pink-red, and in an acidic environment it is orange-yellow.
- Carbon dioxide (CO_2) reacts with water producing an acidic environment.

- Write down the time:_____.
- You must wait at least 45 minutes before checking the results. While you are waiting, perform Part ב.

Part ב — Monitoring the process that takes place in cowpea seeds and seedlings

On your table you have 5 closed test tubes. Each of the test tubes contains slaked lime [בסיס הסידן] powder ($\text{Ca}(\text{OH})_2$).

A wad of cotton wool has been placed on top of the powder. This separates the powder from the seeds or seedlings that will be placed in the test tube but still allows free passage of gases.

Informative Note 2: Slaked lime powder reacts with the gas carbon dioxide (CO_2) and a solid compound is obtained.

You have been given 4 containers with cowpea seeds or seedlings, as follows:

- a container labeled "נבטי לוביה" [cowpea seedlings]
 - a container labeled "נבטי לוביה מוקפאים" [frozen cowpea seedlings]. These seedlings were frozen overnight and thawed in the morning.
 - a container labeled "זרעי לוביה מותפחים" [swollen cowpeas]. These seeds were soaked in water for 12 hours before the experiment began; water has entered the seeds and they have swelled.
 - a container labeled "זרעי לוביה יבשים" [dry cowpea seedlings]
- ב. Use a glass marking pen to write "נבטים" [seedlings] on one of the test tubes containing slaked lime powder, "מוקפאים" [frozen] on the second test tube, "מותפחים" [swollen] on the third test tube, "יבשים" [dry] on the fourth test tube, and "בקרה" [control] on the fifth test tube.
- ג. Transfer 25 seedlings to the test tube labeled "נבטים". You may use the tweezers, but avoid damaging the radicle [שורשון] area of the seedlings (see Figure 1).

Note: Some of the seedlings still have a green seed coat [קליפת הזרע], and some have lost it. The seed coat does not affect the process, so you can use seedlings with or without a seed coat.

— Put the test tube back in the stand.

ד. Repeat Item ג with 25 frozen seeds and the corresponding test tube.

ה. Repeat Item ג with 25 swollen seeds and the corresponding test tube.

— Repeat Item ג with 25 dry seeds and the corresponding test tube.

Do not add anything to the "בקרה" test tube.

ו. Lay 3-4 paper towels on the table.

You have been given pipettes. Each pipette is attached to a stopper.

— Cap the test tube labeled "בקרה" using one of the stoppers attached to a pipette.

This is an **experiment set-up** [מערכת ניסוי] (see Figure 2).

Figure 2: Experiment set-up

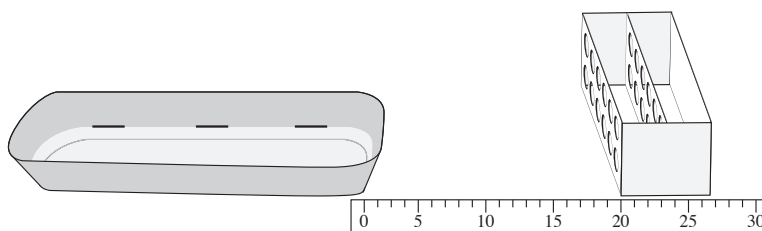


— Carefully twist the stopper to tighten it, and place the experiment set-up on the paper towels.

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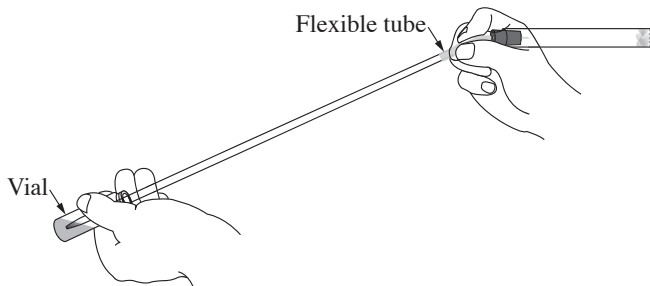
- ז. Cap the test tubes labeled "נבטים", "מוקפאים", "מותפחים", and "יבשים" so that you can prepare 4 more experiment set-ups according to the instructions in Item ו.
- ח. You have a container labeled "מי ברז – חלק ב" [tap water for Part ב] and an aluminum pan. There are line markings on the inside wall of the pan.
- Pour tap water into the pan up to the marked lines.
 - If the water is higher than the marked lines, use a disposable cup to remove some water, and pour it back into the container marked "מי ברז – חלק ב".
 - Turn the test tube stand on its broad side and place it about 20 cm from the pan (see Figure 3.א).

Figure 3.א: Position of the test tube stand and the pan



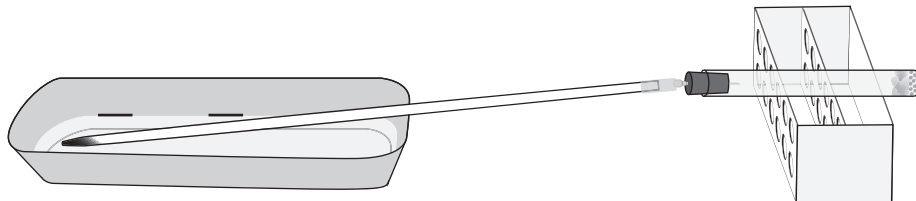
- ט. In this item you will start working with the experiment set-ups you prepared in Items ו and ז. **Before you continue the experiment, carefully read the instructions in this item and look at Figures 3.ב and 3.ג.**
- You have a vial of "פנול אדום" [phenol red] solution. Uncap the vial.
 - Lift the "בקרה" experiment set-up with one hand, grasping the flexible tube with your fingers.
 - Use your other hand to hold and tilt the vial of dye (see Figure 3.ב).
 - Dip the tip of the pipette in the red liquid that is in the vial. Squeeze the flexible tube with your fingers and then let go.
 - This will draw up some red liquid into the pipette.
 - The red color of the liquid will make it easier for you to see the level of liquid in the pipette.

Figure 3.ג: Withdrawing red liquid



- Place the test tube across the broad side of the test tube stand, and lay the pipette diagonally in the pan so that the tip containing the red liquid is immersed in the water in the pan (see Figure 3.g).

Figure 3.g: Arrangement of the experiment set-up



- י. Repeat Item ט with the other experiment set-ups, and place them next to each other alongside the "בקרה" set-up.

Note: The level of red liquid does not have to be equal in all the pipettes.

- Cap the phenol red vial.

- יא. Once the tips of all five pipettes are in the water, write down the time _____.

Wait 5 minutes for the experiment set-ups to stabilize.

- יב. 5 minutes after the time you recorded in Item יא, without moving the pipettes, draw a line with a glass marking pen to mark the level of the red liquid in each of the pipettes.

- Write down the time _____. This is the experiment's **start time**.

- יג. **Note:** Do not move the experiment set-ups or touch them for an additional 10 minutes, and do not re-tighten the stoppers.

After 10 minutes, mark a line again at the level of the red liquid in each of the pipettes, and use a ruler to measure the distance between the two lines.

- While you are waiting, read Informative Note 3 below, and answer Question 13 on the following page.

Informative Note 3:

- Each experiment set-up is a closed system in which a change in volume of the gases causes movement of the liquid in the pipette. When the volume of gases in the set-up decreases, the red liquid in the pipette moves toward the test tube stopper.
- The gas carbon dioxide (CO_2) does not affect the volume of gases in the system, because it reacts with the slaked lime at the bottom of the test tube and forms a solid compound whose volume is negligible.
- Changes in room temperature may affect the volume of gases in the system and cause the liquid to move.

Answer Question 13.

(15 points) **13.א.** In **your notebook**, draw a table to summarize the experiment (with the 5 experiment set-ups) and its results.

(4 points) **ב.** Give the table in your notebook a title and suitable column headings.

יד. After at least 10 minutes have passed from the time you recorded in Item **יב**, mark the final level of the red liquid in each of the pipettes.

- Add a small circle at the end of the line so that you know this line marks the level of the red liquid at the end of the experiment.

For example: ●——

Note: It is possible that in one (or more) of the set-ups the liquid moved back (away from the test tube stopper). Mark the final level of liquid in this case too.

טו. Take the 5 test tubes with pipettes off the stand and put them on the paper towels on your table.

- For each pipette, use a ruler to measure the distance from the initial line (which you marked at the start time in Item **יב**) to the final line (which you marked in Item **יד**).
- Write the results of your measurements in the table in **your notebook**. If the liquid moved back (away from the test tube stopper), add "—" (minus) next to the result you recorded.

Answer Questions 14-17.

(5 points) **14.א.** Explain why it was important to include a control set-up in this experiment.

(4 points) **ב.** Sometimes the red liquid moves forward (toward the test tube stopper) in the "בקה" set-up as well.

In this case, the result obtained in this set-up should be deducted from the result obtained in each of the other experiment set-ups (Note: No need to actually do this).

Using Informative Note 3 explain why this result should be deducted.

(4 points) **15.א.** What is the dependent variable that was measured in this experiment?

(3 points) **ב.** Explain how the way it was measured is appropriate for measuring the dependent variable.

(4 points) **ג.** Explain the effect of the biological process you measured in the "נבטים" experiment set-up on one of the processes that occur during seedling growth.

(4 points) **16.א.** The percentage of water in dry seeds is very low. When the seeds were soaked, water entered the seeds and they swelled.

Use this fact to explain the results obtained in the "יבשים" experiment set-up and in the "מותפחים" experiment set-up.

(4 points) **ב.** When seedlings are frozen, ice crystals form inside the seedling cells. These crystals damage the cell membranes. Use this fact to explain the result you obtained in the "מוקפאים" experiment set-up.

- (2 points) **17. א.** List two factors that were kept constant in Part ב of the experiment (other than temperature).
- (3 points) **ב.** Choose one of these factors and explain why it was important to keep this factor constant.

Checking the results of Part א

ט. At least 45 minutes after the time you recorded in Item א, look at the two test tubes to which you added phenol red and which were placed in the cup labeled "חלק א" (in Item א). If there is no change in the color of the agar in any of the test tubes, wait a further 15 minutes until there is a change in color in one of the test tubes.

While you are waiting you may answer Question 20.

After a change in color occurs in one of the two test tubes from Part א, answer Questions 18-20.

- (5 points) **18. א.** (1) What color is the agar in the "אגר" test tube, red or orange-yellow?
- (2) What color is the agar in the "נבטים באגר" test tube, in the area in which the radicles grew, red or orange-yellow?
- (3 points) **ב.** Based on the information in Informative Note 1 (page 2), what process took place in the radicles and why did it cause a change in indicator color?

19. The table below presents possible alternatives for the two parts of the experiment you conducted.

	Part א (Items א and ט)	Part ב (Items טו-טז)
i	Qualitative experiment / Quantitative experiment	Qualitative experiment / Quantitative experiment
ii	Monitoring the reactant (starting material) in the process / Testing one of the process's products	Monitoring the reactant (starting material) in the process / Testing one of the process's products

- (4 points) **א.** (1) Use the information in Informative Note 1 and in Informative Note 3, and circle the correct alternatives in lines i-ii in each of the parts of the table above.
- (2) Draw the table in your notebook, and copy only the correct answers that you circled into the appropriate spaces in the table.
- (3 points) **ב.** Explain the alternatives you selected in line i of the table in your **notebook**.

20. The seedlings on your table were germinated in the dark.

- (3 points) **א.** Explain what allows the seedlings to develop without any light.
- (2 points) **ב.** Can the seedlings continue developing and growing without light? Explain.

/continued on page 8/

Part א — Analysis of experimental results: Effect of duration of storage on the viability of soy seeds

Seeds are the units of propagation [יחידות הריבוי] of plants. Inside the seed is an embryo which is the product of a fertilization process. After germination, the embryo develops into a new plant. A viable seed is a seed whose embryo is alive and which can germinate under suitable conditions. The Agricultural Research Organization in Israel has a "gene bank" where plant seeds are stored. These are seeds of wild plants with agricultural significance or of endangered [בסכנת הכחדה] rare plants. The gene-bank scientists routinely check the viability of the seeds so that it will be possible to plant them in the future. If the viability of seeds of a certain species decreases, the scientists germinate the seeds, grow them into plants, and then collect and store the fresh seeds.

Scientists were interested in testing the viability of soy seeds during storage.

Experiment 1:

The scientists stored the seeds at a temperature of 25°C. At certain intervals they took a sample of the stored seeds, germinated them, and 8 days later checked the percentage of germination. The results of their experiment are shown in Table 1.

Table 1

Seed storage time (months)	Germination percentage (percent)
0	95
3	85
6	80
9	75
12	70
18	65

- (3 points) **21.א.** What type of graphical representation is most suited to describing the results shown in Table 1, a continuous graph or a bar diagram? Explain your answer.
- (6 points) **ב.** **In your notebook**, use a suitable graphical representation to present the experimental results shown in Table 1.
- (5 points) **22.א.** Describe the results of the experiment, based on your graphical representation.
- (3 points) **ב.** Use the results to hypothesize the expected germination percentage of soy seeds stored under the same conditions for 24 months. Note: You do not need to specify an exact number. Explain your answer.

Some species of plants have seeds that only germinate in certain seasons or whose germination process is very long.

The scientists therefore tried another, faster, method of testing seed viability.

This method is described below.

A certain quantity of seeds is soaked in distilled water. After 24 hours, the electrical conductivity of the soaking solution is measured. The principle behind this method of measuring viability is that a solution that contains salts is electrically conductive. The higher the concentration of salts in the solution, the greater its electrical conductivity.

Experiment 2:

Scientists stored soy seeds at a temperature of 25°C. At certain intervals they took a sample of stored seeds, soaked them in distilled water, and measured the electrical conductivity of the soaking solution. When seeds contain dead cells or cells with damaged membranes, various substances, including salts, leak into the soaking solution.

The results of this experiment are shown in Table 2.

Table 2

Seed storage time (months)	Electrical conductivity of the soaking solution (relative units)
0	60
3	63
6	70
9	73
12	80
18	115

- (5 points) **23.א.** Explain the percentage of germination results in Experiment 1, based on the measurements of electrical conductivity (Table 2).
- (3 points) **ב.** Students soaked two groups of seedlings in distilled water: seedlings ("נבטים") and "נבטים מוקפאים" (seedlings that were frozen and then thawed), like the ones you investigated in the experiment in Part ב.
- In which soaking solution will electrical conductivity be higher, in the seedlings or frozen seedlings? Explain, using the results of your investigation in Part ב (which you provided in answer to Question 13).

(Note: The next question is on the following page.)

/continued on page 10/

In 1963, an archeological dig was conducted in Metzada [מצדה] in the east Judean Desert. In the Judean Desert the humidity of the air and the soil are very low. In the dig, several date pits about 2000 years old were found. Scientists tried to germinate the seeds and one of them sprouted and developed into a palm tree (the tree has been named Metushelah after the oldest person in the Bible).

- (1 point) **24. א.** Explain what made it possible for the seed to germinate after so long. Base your answer on the conditions in the habitat in which the seed was preserved and on the results you obtained in Part ב of your experiment.
- (2 points) **ב.** Can the fact that only one of the seeds found in Metzada germinated be explained by the results of Experiment 1 shown on page 8? Explain.

Give the proctor your exam paper and your notebook.

Good Luck!

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בהצלחה!

זכות היוצרים שמורה למדינת ישראל.
אין להעתיק או לפרסם אלא ברשות משרד החינוך.

Practical Exam in Biology

בחינת בגרות מעשית בביולוגיה

Problem 3

בעיה 3

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

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Instructions for examinees:

הוראות לנבחן:

א. Duration of the exam: Three hours

א. משך הבחינה: שלוש שעות.

ב. Material that may be used during the exam:
Hebrew-foreign language / foreign language-
Hebrew dictionary

ב. חומר עזר מותר בשימוש:
מילון עברי-לועזי / לועזי-עברי

ג. Special instructions:

ג. הוראות מיוחדות:

- (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 that you obtained, even if they are not as expected.

- (1) קרא את ההנחיות ביסודיות ושקול היטב את צעדיך.
- (2) רשום בעט את כל תצפיותיך ותשובותיך (גם סרטוטים).
- (3) בסס את תשובותיך על תצפיותיך ועל התוצאות שקיבלת, גם אם הן אינן תואמות את הצפוי.

Write in the exam booklet only. Write the word "טייטה" 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.

כתוב במחברת הבחינה בלבד. רשום "טייטה" בראש כל עמוד המשמש טייטה. כתיבת טייטה בדפים שאינם במחברת הבחינה עלולה לגרום לפסילת הבחינה.

Good Luck!

בהצלחה!

Problem 3

In this problem, you will examine processes that take place in seeds and seedlings.

The questions in this exam are numbered **25-36**. The point value of each question is given on the left. Answer all of the questions in your notebook.

Part א — Examining a process that occurs in lentils [עדשים]

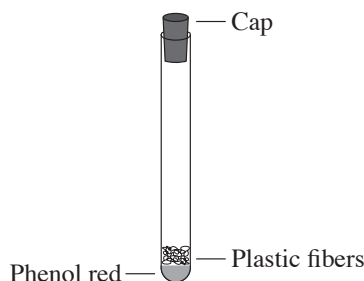
- א. On your table are three test tubes marked "חלק א" [Part א] and a container marked "מים לניסוי — חלק א" [water for the experiment — Part א].
- Use a glass marking pen to write "זרעים" [seeds] on one test tube, "גבטים" [seedlings] on the second, and "בקרה" [control] on the third.
 - Use a Pasteur pipette to transfer 1 ml of "מים לניסוי — חלק א" to each of the three test tubes.
- ב. You have a vial containing a solution of phenol red [פנול אדום]. Use the dropper to add 1 drop of phenol red to each of the three test tubes.
- The color of the liquid in the test tubes should be pink-red. If the color in all three test tubes is not the same, ask the proctor for help.

Informative Note 1:

- Phenol red is an indicator [חומר בוחן]. In an alkaline environment it is pink-red, and in an acidic environment it is orange-yellow.
- Carbon dioxide (CO_2) reacts with water, producing an acidic environment.

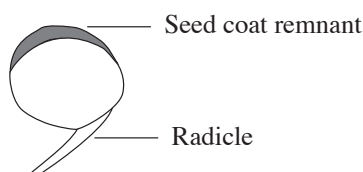
- ג. On your table you have a container with plastic fibers. Place one wad of plastic fibers in each of the three test tubes that you marked.
- Use the tip of the Pasteur pipette to push the wads of plastic fibers down until they are just above the surface of the liquid in the test tubes (see Figure 1). The plastic fibers will separate the liquid at the bottom of the test tube from the seeds or seedlings that will be placed in the test tubes, but will allow free passage of gases.

Figure 1: Test tube with phenol red and plastic fibers



- ד. On your table you have a container marked "זרעי עדשים יבשים" [dry lentil seeds], a container marked "נבטי עדשים" [lentil seedlings], and a disposable cup marked "חלק א" [Part א]. You may use the tweezers to transfer seeds and seedlings to the test tubes, but avoid damaging the radicle [שורשון] area of the seedlings (see Figure 2).

Figure 2: Lentil seedling



Note: Some of the seedlings still have a seed coat [קליפת הזרע], and some have lost it. The seed coat does not affect the process you are testing, so you can use seedlings with or without a seed coat.

- Transfer 15 seedlings to the test tube labeled "נבטים" and 15 dry seeds to the test tube labeled "זרעים". Do not put anything in the "בקרה" test tube.
- Cap the three test tubes and put them in the disposable cup on your table marked "חלק א".
- Close the container with the remaining seedlings so that they do not dry out.
- Write down the time:_____.

You must wait at least 45 minutes before checking the results. While you are waiting, perform Part ב.

Part ב — Monitoring the process that takes place in lentil seeds and seedlings

On your table you have 4 closed test tubes. Each of the test tubes contains slaked lime powder [אבקת בסיס הסידן] ($\text{Ca}(\text{OH})_2$).

A wad of cotton wool has been placed on top of the powder. This separates the powder from the seeds or seedlings that will be placed in the test tube, but still allows free passage of gases.

Informative Note 2: Slaked lime powder reacts with the gas carbon dioxide (CO_2) and a solid compound is obtained.

You have been given 3 containers with seeds or seedlings, as follows:

- a container labeled "זרעי עדשים מותפחים" [swollen lentil seeds]. These seeds were soaked in water for about 12 hours before the experiment began; water has entered the seeds and they have swelled.
 - a container labeled "נבטי עדשים" [lentil seedlings]
 - a container labeled "נבטי עדשים מוקפאים" [frozen lentil seedlings]. These seedlings were frozen overnight and thawed in the morning.
- ה. Use a glass marking pen to write "מותפחים" [swollen] on one of the test tubes containing slaked lime powder, "נבטים" [seedlings] on the second test tube, "מוקפאים" [frozen] on the third test tube, and "בקרה" [control] on the fourth test tube.
- ו. Transfer 25 swollen lentil seedlings to the test tube labeled "מותפחים".
— Put the test tube back in the stand.
- ז. Repeat Item ו with 25 seedlings and the corresponding test tube.
- ח. Repeat Item ו with 25 frozen seedlings and the corresponding test tube.
Do not add anything to the "בקרה" test tube.
- ט. Lay 3-4 paper towels on the table.
You have been given pipettes. Each pipette is attached to a stopper.
Cap the test tube labeled "בקרה" using one of the stoppers attached to a pipette.
This is an **experiment set-up** [מערכת ניסוי] (see Figure 3).

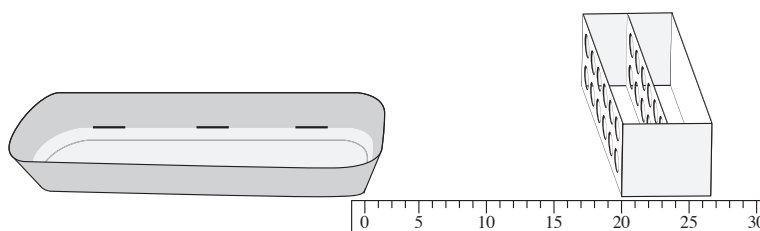
Figure 3: Experiment set-up



- Carefully twist the stopper to tighten it, and place the experiment set-up on the paper towels.

- י. Cap the test tubes labeled "מותפחים", "נבטים", and "מוקפאים" to prepare 3 more experiment set-ups according to the instructions in Item ט.
- יא. You have a container labeled "מי ברז – חלק ב" [tap water for Part ב] and an aluminum pan. There are line markings on the inside wall of the pan.
- Pour tap water into the pan up to the marked lines.
If the water is higher than the marked lines, use a disposable cup to remove some water, and pour it back into the container marked "מי ברז – חלק ב".
 - Turn the test tube stand on its broad side and place it about 20 cm from the pan (see Figure 4.א).

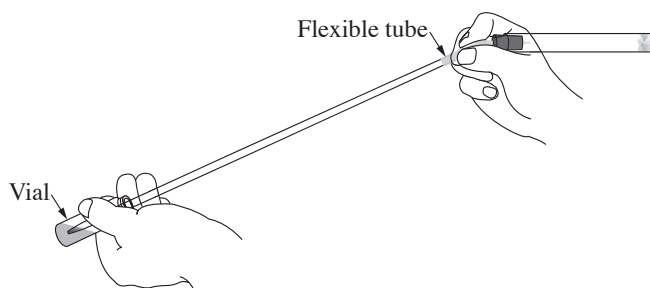
Figure 4.א: Position of the test tube stand and the pan



- יב. In this item you will start working with the experiment set-ups you prepared in Items ט and י. **Before you continue the experiment, carefully read the instructions in this item and look at Figures 4.ב and 4.ג.**

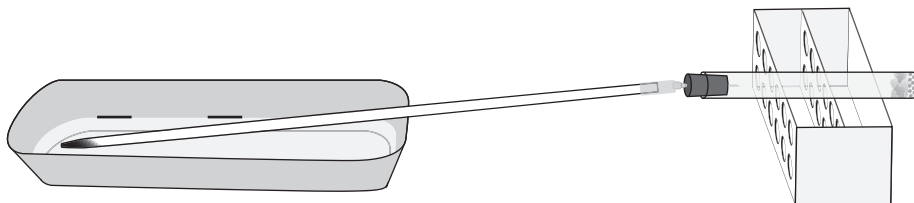
- You have a vial of dye marked "פנול אדום" [phenol red]. Uncap the vial.
- Lift the "בקרה" experiment set-up with one hand, grasping the flexible tube with your fingers.
Use your other hand to hold and tilt the vial of dye (see Figure 4.ב).
- Dip the tip of the pipette in the red liquid that is in the vial. Squeeze the flexible tube with your fingers and then let go.
This will draw up some red liquid into the pipette.
The red color of the liquid will make it easier for you to see the level of liquid in the pipette.

Figure 4.ג: Withdrawing red liquid



- Place the test tube across the broad side of the test tube stand, and lay the pipette diagonally in the pan so that the tip containing the red liquid is immersed in the water in the pan (see Figure 4.g).

Figure 4.g: Arrangement of the experiment set-up



- יג. Repeat Item יב with the other experiment set-ups, and place them next to each other alongside the "בקרה" set-up.

Note: The level of red liquid does not have to be equal in all the pipettes.

- Cap the phenol red vial.

- יד. Once the tips of all four pipettes are in the water, write down the time _____.
Wait 5 minutes for the experiment set-ups to stabilize.

- טו. 5 minutes after the time you recorded in Item יד, without moving the pipettes, draw a line with a glass marking pen to mark the level of the red liquid in each of the pipettes.

- Write down the time _____. This is the experiment's **start time**.

- טז. **Note:** Do not move the experiment set-ups or touch them for an additional 10 minutes, and do not re-tighten the stoppers.

After 10 minutes, mark a line again at the level of the red liquid in each of the pipettes, and use a ruler to measure the distance between the two lines.

- While you are waiting, read Informative Note 3 below, and answer Question 25 on the following page.

Informative Note 3:

- Each experiment set-up is a closed system in which a change in volume of the gases causes movement of the liquid in the pipette. When the volume of gases in the set-up decreases, the red liquid in the pipette moves toward the test tube stopper.
- The gas carbon dioxide (CO_2) does not affect the volume of gases in the system, because it reacts with the slaked lime at the bottom of the test tube and forms a solid compound whose volume is negligible.
- Changes in room temperature may affect the volume of gases in the system and cause the liquid to move.

Answer Question **25**.

(14 points) **25.א.** In **your notebook**, draw a table to summarize the experiment (with the 4 experiment set-ups) and its results.

(4 points) **ב.** Give the table in your notebook a title and suitable column headings.

י. After at least 10 minutes have passed from the time you recorded in Item ט, mark the final level of the red liquid in each of the pipettes.

- Add a small circle at the end of the line so that you know this line marks the level of the red liquid at the end of the experiment.

For example: ●——

Note: It is possible that in one (or more) of the set-ups the liquid moved back (away from the test tube stopper). Mark the final level of liquid in this case too.

יח. Take the 4 test tubes with pipettes off the stand and put them on the paper towels on your table.

- For each pipette, use a ruler to measure the distance from the initial line (which you marked at the start time in Item ט) to the final line (which you marked in Item י).
- Write the results of your measurements in the table in **your notebook**. If the liquid moved back (away from the test tube stopper), add "—" (minus) next to the result you recorded.

Answer Questions **26-29**.

(5 points) **26.א.** Explain why it was important to include a control set-up in this experiment.

(4 points) **ב.** Sometimes the red liquid moves forward (toward the test tube stopper) in the "בקרה" set-up as well.

In this case, the result obtained in this set-up should be deducted from the result obtained in each of the other experiment set-ups (Note: No need to actually do this).

Using Informative Note 3, explain why this result should be deducted.

(4 points) **27.א.** What is the dependent variable that was measured in this experiment?

(3 points) **ב.** Explain how the way it was measured is appropriate for measuring the dependent variable.

(4 points) **ג.** Explain the effect of the biological process you measured in the "נבטים" experiment set-up on one of the processes that occur during seedling growth.

(3 points) **28.א.** The percentage of water in dry seeds is very low. When the seeds were soaked, water entered the seeds and they swelled.

Use this fact to explain the result obtained in the "מותפחים" experiment set-up.

(4 points) **ב.** When seedlings are frozen, ice crystals form inside the seedling cells. These crystals damage the cell membranes. Use this fact to explain the result you obtained in the "מוקפאים" experiment set-up.

- (2 points) **29. א.** List two factors that were kept constant in Part ב of the experiment (other than temperature).
- (3 points) **ב.** Choose one of these factors and explain why it was important to keep this factor constant.

Checking the results of Part א

יט. At least 45 minutes after the time you recorded in Item ט, gently shake the three test tubes to which you added phenol red and which were placed in the cup labeled "חלק א" (in Item ט). If there is no change in color in any of the test tubes, wait a further 15 minutes until there is a change in color in one of the test tubes.

While you are waiting you may answer Question **32**.

After a change in color occurs in one of the three test tubes from Part א, answer Questions **30-32**.

- (5 points) **30. א.** What color is the liquid in each of the three test tubes, red or orange-yellow?
- (5 points) **ב.** Based on the information in Informative Note 1 (page 2), explain the results obtained in each of the three test tubes.

31. The table below presents possible alternatives for the two parts of the experiment you conducted.

	Part א (Items ט-א and יט)	Part ב (Items יח-ה)
i	Qualitative experiment / Quantitative experiment	Qualitative experiment / Quantitative experiment
ii	Monitoring the reactant (starting material) in the process / Testing one of the process's products	Monitoring the reactant (starting material) in the process / Testing one of the process's products

- (4 points) **א. (1)** Use the information in Informative Note 1 and in Informative Note 3, and circle the correct alternatives in lines i-ii in each of the parts of the table above.
- (2)** Draw the table in your notebook, and copy only the correct answers that you circled into the appropriate spaces in the table.
- (3 points) **ב.** Explain the alternatives you selected in line i of the table in your **notebook**.

32. The seedlings on your table were germinated in the dark.

- (3 points) **א.** Explain what allows the seedlings to develop without any light.
- (2 points) **ב.** Can the seedlings continue developing and growing without light? Explain.

Part 3 — Analysis of experimental results: Effect of duration of storage on the viability of soy seeds

Seeds are the units of propagation [יחידות הריבוי] of plants. Inside the seed is an embryo which is the product of a fertilization process. After germination, the embryo develops into a new plant. A viable seed is a seed whose embryo is alive and which can germinate under suitable conditions. The Agricultural Research Organization in Israel has a "gene bank" where plant seeds are stored. These are seeds of wild plants with agricultural significance or of endangered [בסכנת הכחדה] rare plants. The gene-bank scientists routinely check the viability of the seeds so that it will be possible to plant them in the future. If the viability of seeds of a certain species decreases, the scientists germinate the seeds, grow them into plants, and then collect and store the fresh seeds.

Scientists were interested in testing the viability of soy seeds during storage.

Experiment 1:

The scientists stored the seeds at a temperature of 25°C. At certain intervals they took a sample of the stored seeds, germinated them, and 8 days later checked the percentage of germination. The results of their experiment are shown in Table 1.

Table 1

Seed storage time (months)	Germination percentage (percent)
0	95
3	85
6	80
9	75
12	70
18	65

- (3 points) **33.א.** What type of graphical representation is most suitable for describing the results shown in Table 1, a continuous graph or a bar diagram?
Explain your answer.
- (6 points) **33.ב.** **In your notebook**, use a suitable graphical representation to present the experimental results shown in Table 1.
- (5 points) **34.א.** Describe the results of the experiment, based on your graphical representation.
- (3 points) **34.ב.** Use the results to hypothesize the expected germination percentage of soy seeds stored under the same conditions for 24 months. Note: You do not need to specify an exact number. Explain your answer. /continued on page 10/

Some species of plants have seeds that only germinate in certain seasons or whose germination process is very long.

The scientists therefore tried another, faster, method of testing seed viability.

This method is described below.

A certain quantity of seeds is soaked in distilled water. After 24 hours, the electrical conductivity of the soaking solution is measured. The principle behind this method of measuring viability is that a solution that contains salts is electrically conductive. The higher the concentration of salts in the solution, the greater its electrical conductivity.

Experiment 2:

Scientists stored soy seeds at a temperature of 25°C. At certain intervals they took a sample of stored seeds, soaked them in distilled water, and measured the electrical conductivity of the soaking solution. When seeds contain dead cells or cells with damaged membranes, various substances, including salts, leak into the soaking solution.

The results of this experiment are shown in Table 2.

Table 2

Seed storage time (months)	Electrical conductivity of the soaking solution (relative units)
0	60
3	63
6	70
9	73
12	80
18	115

- (5 points) **35. א.** Explain the percentage of germination results in Experiment 1, based on the measurements of electrical conductivity (Table 2).
- (3 points) **ב.** Students soaked two groups of seedlings in distilled water: seedlings ("נבטים") and "נבטים מוקפאים" (seedlings that were frozen and then thawed), like the ones you investigated in the experiment in Part ב.
- In which soaking solution will electrical conductivity be higher, in the seedlings or frozen seedlings? Explain, using the results of your investigation in Part ב (which you provided in answer to Question 25).

(Note: The next question is on the following page.)

/continued on page 11/

In 1963, an archeological dig was conducted in Metzada [מצדה] in the east Judean Desert. In the Judean Desert the humidity of the air and the soil are very low. In the dig, several date seeds about 2000 years old were found. Scientists tried to germinate the seeds, and one seed sprouted and developed into a palm tree (the tree has been named Metushelah after the oldest person in the Bible).

- (1 point) **36.א.** Explain what made it possible for the seed to germinate after so long. Base your answer on the conditions in the habitat in which the seed was preserved and on the results you obtained in Part א of your experiment.
- (2 points) **ב.** Can the fact that only one of the seeds found in Metzada germinated be explained by the results of Experiment 1 shown on page 9? Explain.

Give the proctor your exam paper and your notebook.

Good Luck!

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בהצלחה!

זכות היוצרים שמורה למדינת ישראל.
אין להעתיק או לפרסם אלא ברשות משרד החינוך.

Practical Exam in Biology

בחינת בגרות מעשית בביולוגיה

Problem 4

בעיה 4

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

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Instructions for examinees:

הוראות לנבחן:

א. Duration of the exam: Three hours

א. משך הבחינה: שלוש שעות.

ב. Material that may be used during the exam:

Calculator

Hebrew-foreign language / foreign language - Hebrew dictionary

ב. חומר עזר מותר בשימוש:

מחשבון.

מילון עברי-לועזי / לועזי-עברי.

ג. Special instructions:

ג. הוראות מיוחדות:

(1) Read the instructions carefully and think carefully before each step.

(1) קרא את ההנחיות ביוסודיות ושקול היטב את צעדיך.

(2) Write all of your observations and answers in pen (including sketches).

(2) רשום בעט את כל תצפיותיך ותשובותיך (גם סרטטים).

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

(3) בסס את תשובותיך על תצפיותיך ועל התוצאות שקיבלת,

גם אם הן אינן תואמות את הצפוי.

Write in the exam booklet only. Write the word "טיטה" 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.

כתוב במחברת הבחינה בלבד. רשום "טיטה" בראש כל עמוד המשמש טיטה. כתיבת טיטה בדפים שאינם במחברת הבחינה עלולה לגרום לפסילת הבחינה.

Good Luck!

בהצלחה!

Problem 4

In this problem, you will examine the effect of different alkaline solutions on the pH inside plant cells.

The questions in this exam are numbered **37-48**. The point value of each question is given on the left. Answer all of the questions in your notebook.

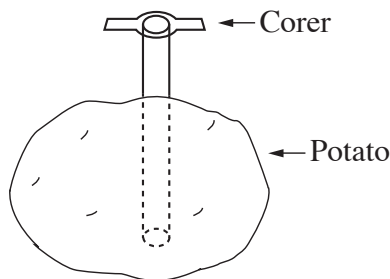
Part א — Learn a method for testing pH in potato tuber cells

I. Preparing slices of potato

You have a disposable plate with a potato tuber. Use a corer [קודח פקקים] to prepare 6 potato cores, each 2 cm long, as follows:

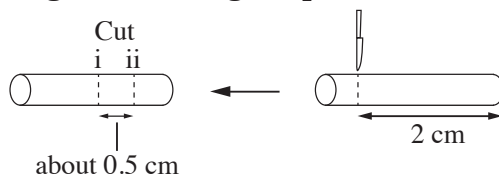
- א. Push the corer (without the insert) into the potato, perpendicularly (not diagonally) to your work surface, and make one core (see Figure 1).
 - Use the corer insert to push out the core onto the plate.

Figure 1: Using the corer to prepare potato cores



- If there are flawed or missing areas in the core, prepare another core in its place.
 - Place the core on a paper towel, and cut off both ends with a knife.
 - Use a ruler and a knife to cut the core into one or more 2 cm long segments (see Figure 2.א.).
 - Prepare more cores and cut them into 2 cm long segments until you have 6 whole, unflawed segments.
- ב. Cut each segment in half (see Cut i in Figure 2.ב.) and cut each half in two again (Cut ii). This will produce 4 slices from each segment, each about 0.5 cm long. You will have a total of 24 slices.

Figure 2: Slicing the potato cores



2.ב. Cut in slices

2.א. Cut in segments

- ג. Transfer all the potato slices to the container on your table marked "לשטיפה" [for rinsing]. You have a container marked "מי ברז" [tap water].
- Pour tap water into the container "לשטיפה" up to the marked line.
 - Use a spoon to gently mix the contents of the container, and then pour the water and slices through your sieve or funnel held over the waste container.
 - Repeat the rinsing process twice more, and place the slices on a paper towel.
 - Use another paper towel to gently dab the excess water off the slices, and cover them with this damp towel that you used to dab off the excess water.

Later you will transfer the slices you prepared to soaking solutions.

II. Learn about the indicator's properties; learn a method for testing penetration of substances into cells

You have a container with a solution of ammonium hydroxide for Part א

[NH_4OH] ("בסיס האמוניום לחלק א"); a container with a neutral red solution ["אדום ניטרלי"]; and a container with water for the experiment ["מים לניסוי"] with a pH that has been adjusted for this experiment.

Informative Note 1: The solution of neutral red serves as an acid-base indicator [חומר בוחן]: In an acidic [חומצית] environment the solution is red, and in an alkaline [בסיסית] environment it is orange.

- ד. Mark one test tube "מים לניסוי" [water for experiment] and one test tube "בסיס" [base].
- Mark a 5 ml pipette "מים" [water] and use it to transfer 5 ml of "מים לניסוי" to the test tube marked "מים לניסוי".
 - Mark a 5 ml pipette "בסיס האמוניום" [ammonium hydroxide] and use it to transfer 5 ml of "בסיס האמוניום לחלק א" solution to the test tube marked "בסיס".
- ה. You have a pipette marked "אדום ניטרלי" [neutral red] which has been marked with a white line indicating a volume of 2.5 ml.
- Use the pipette to add 2.5 ml of neutral red solution to each of the test tubes "מים לניסוי" and "בסיס".
- Cap the test tubes and shake them gently to mix the liquids.
 - Look at the color of the solutions in your test tubes. Determine whether the color in each test tube is red or orange.
- Solution color in the "מים לניסוי" test tube: _____;
- solution color in the "בסיס" test tube: _____.
- ו. You have some small beakers. Mark an "א" under the rim of a small beaker and prepare a soaking solution in it, as follows: Use the "מים" pipette to transfer 5 ml of "מים לניסוי" to Beaker א.
- Use the "אדום ניטרלי" pipette to transfer 2.5 ml of neutral red solution to Beaker א.
- Gently shake the beaker to mix the liquids.
- Write down the color of the soaking solution in Beaker א: _____.

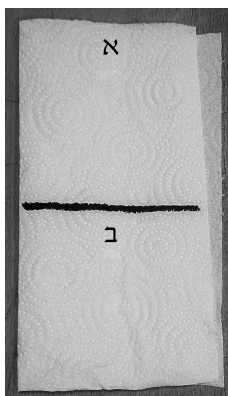
- ז. Place 4 slices of potato in the soaking solution in Beaker א.
— Record the time: _____ and wait 5 minutes. While you are waiting perform Items ח and ט.

Your experiment results will not be affected if soaking continues longer than 5 minutes.

Informative Note 2: The neutral red indicator can pass through the membrane of living cells and does not affect processes in the cells.

- ח. Mark a small beaker "ב".
— Use the "בסיס האמוניום לחלק א" pipette to transfer 5 ml of "בסיס האמוניום לחלק א" to Beaker ב.
ט. Fold a paper towel in half to make a double layer.
— Use a glass marking pen to draw a line through the middle of the folded paper towel. Mark an "א" on the top part of the paper towel and a "ב" under the line (see Figure 3).

Figure 3: Marking the folded paper towel



- י. About 5 minutes after the time you recorded in Item ז, use the tweezers to carefully remove all the slices from Beaker א, and place them on the paper towel close to the א marking.
— Move the slices from the wet area to a dry area on Area א of the paper towel where there is no dye residue.
— Wipe the tips of the tweezers with a paper towel.

Answer Question 37.א.

(4 points) 37.א. Copy the following sentences (1)-(3) to your notebook.

In **your notebook**, circle the correct option in each of the sentences, basing your answer on the color of the slices in front of you, the information in Informative Notes 1 and 2, and the results you recorded in Items ח and ט.

- (1) The pH of the soaking solution in Beaker א is: acidic / alkaline.
- (2) The color of the slices after soaking in water for the experiment (Beaker א) is: red / orange.
- (3) The pH of the solution **inside the potato cells** after soaking in Beaker א is: acidic / alkaline.

- א. Use the tweezers to gently transfer 2 slices from Area א on the paper towel to Beaker ב, which contains ammonium hydroxide solution.
- Write down the time _____ and wait 3 minutes.
- ב. 3 minutes after the time you recorded in Item א, use the tweezers to gently remove the slices from Beaker ב and place them on the paper towel close to the ב marking.
- Move the slices from the wet area to a dry area on Area ב of the paper towel where there is no dye residue.
 - **Immediately** determine whether the color of the slices after soaking in the ammonium hydroxide solution (Beaker ב) is red or orange: _____ .
 - Wipe the tips of the tweezers with a paper towel.
- Note:** If the slices you took out of both beakers are all the same color, ask the proctor for help.

Answer Questions **37.ב-38.**

(5 points) **37.ב.** Copy the following sentences (1)-(4) to your notebook.

In **your notebook**, circle the correct option in each of the sentences, basing your answer on the information in Informative Notes 1 and 2, and the results you recorded in Items ה and ב.

- (1) The pH of the soaking solution in Beaker ב is: acidic / alkaline.
- (2) The color of the slices after soaking in an ammonium hydroxide solution (Beaker ב) is: orange / red.
- (3) The pH of the solution **inside the potato cells** after soaking in Beaker ב is: acidic / alkaline.
- (4) Ammonium hydroxide penetrated / did not penetrate the potato cells.

(4 points) **38.א.** **Explain** how you checked whether ammonium hydroxide had penetrated the potato cells.

(2 points) **ב.** Is the method you used to test whether ammonium hydroxide had penetrated the potato cells quantitative or qualitative? Explain.

- Give the proctor the container with the solution of ammonium hydroxide for Part א.
- Transfer the paper towel marked א and ב, the remaining potato slices on it, Beakers א and ב, and the solutions they contain into the waste container.

Part ב — Testing penetration of different alkaline solutions into potato tuber cells

- יג. Mark 3 small beakers 1, 3, and 5 (near the rim).
- יד. You have three test tubes. Each one contains a different alkaline solution: sodium hydroxide [בסיס הנתרן] (NaOH), "בסיס האמוניום לחלק ב" [ammonium hydroxide for Part ב], or potassium hydroxide [בסיס האשלגן] (KOH). The concentration of all the solutions is **0.1M**.
- Mark a 5 ml pipette "בסיס הנתרן" and another 5 ml pipette "בסיס האשלגן". You already have a "בסיס האמוניום" pipette which you marked in Part א.
- Using the corresponding pipettes, transfer solutions to the beakers as follows:
- in Beaker **1**, put 5 ml of sodium hydroxide solution
 - in Beaker **3**, put 5 ml of ammonium hydroxide solution
 - in Beaker **5**, put 5 ml of potassium hydroxide solution.
- טו. Mark 3 small beakers 2, 4, and 6 (near the rim).
- You have 1 ml pipettes. Mark one pipette "בסיס הנתרן", another pipette "בסיס האמוניום" and a third "בסיס האשלגן". You also have a "מים" pipette which you marked in Part א.
- Using the corresponding pipettes, add water for the experiment [מים לניסוי] and an alkaline solution to each of the beakers according to Table 1, below.

Table 1

Beaker	Volume of "מים לניסוי" (ml)	Volume of 0.1M sodium hydroxide solution (ml)	Volume of 0.1M ammonium hydroxide solution (ml)	Volume of 0.1M potassium hydroxide solution (ml)	Final concentration of alkaline solution (M)
2	4.5	0.5	----	----	
4	4.5	-----	0.5	----	
6	4.5	-----	----	0.5	

- טז. Calculate the concentrations of the alkaline solutions that you prepared in Beakers 2, 4, and 6 (Item טו), and write down the results of your calculations in the appropriate places in Table 1.
- יז. Use the "אדום ניטרלי" pipette to add 2.5 ml of neutral red solution to each of the beakers 1-6.
- Gently shake each beaker to mix the liquids it contains.
- יח. Transfer 3 slices of potato from the paper towel you prepared in Item ג to each of the soaking solutions in Beakers 1-6.
- Write down the time: _____, and wait 10 minutes.
 - While you are waiting, answer Question **39.א.** and perform Item ט.
- Your experiment's results will not be affected if the soaking continues for longer than 10 minutes.

Answer Question **39.א.**

(6 points) **39.א.** In your notebook, prepare Table 2 to summarize the experiment set-up that you ran in Part ב (solutions 1-6). Include 4 **additional** empty columns in your table.

Note: Draw the table across the length of the page to allow more space.

- יט. You have 3 paper towels. Fold each one in half and place them side by side on the table. Draw a line through the middle of each one (see Figure 3).
- Mark the top of one paper towel "1" and the bottom half under the line "2". Mark a second paper towel "3" and "4", and a third paper towel "5" and "6", in the same way.
- כ. 10 minutes after the time you recorded in Item יח, use the tweezers to carefully remove all the slices from the soaking solution in Beaker 1, and place them on the paper towel close to the "1" mark.
- Move the slices from the wet area to a dry area on Area 1 of the paper towel where there is no dye residue.
 - **Immediately** determine whether the color of the slices from the soaking solution in Beaker 1 is red or orange: _____.
- Note: If the three slices that were soaked in the same solution are not all the same color, record the color of two slices that have a similar color.
- Wipe the tips of the tweezers with a paper towel.
- כא. Repeat Item כ with the slices in Beakers 2-6 and the corresponding areas of the paper towels.
- **Immediately** determine whether the color of the slices from the soaking solutions in each of the beakers is red or orange.
- Beaker 2: _____
- Beaker 3: _____ Beaker 4: _____
- Beaker 5: _____ Beaker 6: _____

Answer Questions **39.ב.-45.**

- (6 points) **39.ב.** (1) Write down the color of the soaking solutions in Beakers 1-6 in an empty column in Table 2 in **your notebook**.
- (2) Based on the color of the solution in each of the beakers 1-6, determine whether the pH of the soaking solution is acidic or alkaline. Write down your answers in the appropriate spaces in another empty column in Table 2 in **your notebook**.

- (4 points) **40. א.** Write down the results in an empty column in Table 2 in **your notebook**: the color of the slices soaked in each of the solutions 1-6 (Items כ and כא).
- (4 points) **ב.** Based on the results you recorded in Item א, determine whether, at the end of the experiment, the pH in the cells of potato slices soaked in Beakers 1-6 is acidic or alkaline. Write down your answers in the appropriate spaces in an empty column in Table 2 in **your notebook**.
- (5 points) **41. א.** What are the independent variables in the experiment you conducted?
- (5 points) **ב.** Give your table a title and suitable column headings.
- (4 points) **42. א.** Based on the results of the experiment in the slices soaked in Beakers 2, 4, and 6, determine for each of the bases whether it **did or did not** penetrate the potato cells.
Which results support your answers?
- (4 points) **ב.** Based on the results of the experiment in the slices soaked in Beakers 4 and 6, is it correct to conclude that the result for the slices soaked in Beaker 4 was affected by the type of alkaline solution and not by the concentration of the alkaline solution? Explain.
- (4 points) **43. א.** Based on the results of the experiment in the slices soaked in Beakers 1 and 2, what can you conclude about the effect of the alkaline solutions' concentration on the penetration of the base into potato cells? Specify which results support your conclusion.
- (4 points) **ב.** Suggest a possible explanation for the effect of the concentration of an alkaline solution on penetration of the base into the potato cells.
- (4 points) **44. א.** Explain how the temperature of the soaking solution might affect the penetration of the base into potato cells.
- (2 points) **ב.** The temperature of the soaking solutions in the experiment set-up you ran in Part א is a:
- i dependent variable
 - ii constant factor
 - iii method for testing the dependent variable
 - iv control
- Copy the correct answer to **your notebook**.

45. Students conducted an experiment like the one you ran in Part א. They noticed that the color of the slices soaked in Beaker **ב** (ammonium hydroxide) and then placed on the paper towel changed after some time and their color became similar to the color of the slices soaked in Beaker **א**.

The students proposed an explanation: The color changed due to the respiration process in the potato cells.

(5 points) **א.** Explain how the process of respiration can affect the change in color of the potato cells.

(3 points) **ב.** The following measures, i-ii, can be used to test whether respiration is taking place inside the potato cells in the soaking solution:

- i amount of oxygen in the solution at the end of the experiment
- ii temperature of the solution at the end of the experiment

Choose one measure and specify which result would be evidence of respiration inside the potato cells: an **increase** or a **decrease** in this measure.

Explain your answer.

Part 3 — Analysis of research results: Effect of pH in an external solution on the internal pH of plant cells

Researchers were interested in the effect of the pH of an external solution on the pH of the cytoplasm of plant cells.

Earlier studies showed that the pH in the cytoplasm of plane tree [דולב] leaves remains a constant 7.4-7.5.

The researchers took some plane tree leaves and cultured them in solution under optimal conditions. The solution contained dissolved oxygen and other substances that are essential to cells. The pH of this solution was 6.5.

Several hours later the researchers divided the solution and the cells it contained into 7 containers. In each container they created a culture solution with a different pH and kept the pH constant throughout the experiment.

After 4 hours, the researchers measured the pH in the cytoplasm of the cells in each of the containers.

Their results are shown in Table 3, below.

Table 3

pH in the culture solution	pH in the cytoplasm after 4 hours
3.5	6.5
4.0	7.0
4.5	7.5
6.0	7.5
7.5	7.5
8.0	8.0
9.5	8.5

Answer Questions **46-48**.

- (3 points) **46. א.** What type of graphical representation is most suited to describing the results shown in Table 3, a continuous graph or a bar diagram? Explain your answer.
- (6 points) **47. ב.** **In your notebook**, use the type of graphical representation you chose in Item א to present the experimental results shown in Table 3.

(4 points) **47.א.** Under optimal conditions, the constant pH in the cytoplasm of plane tree cells is 7.4-7.5.

Based on the results, determine at what pH levels in the **culture solution** is the cytoplasm pH higher than 7.5 and at what pH levels in the **culture solution** is the cytoplasm pH lower than 7.4.

(5 points) **ב.** Explain the importance of maintaining a constant pH in the cytoplasm.

(4 points) **48.א.** During the experiment described in Part א, the researchers also tested oxygen consumption rates in the cells.

During the tested interval, the number of cells did not increase.

Some of their results are shown in Table 4, below.

Suggest a possible explanation for the difference in rate of oxygen consumption between Treatment 1 and Treatment 2.

Table 4

	Treatment	Results	
	pH in culture solution*	pH in cytoplasm*	Oxygen consumption rate (micromole/minute/gram of leaf)
1	4.5	7.5	0.50
2	7.5	7.5	0.30

*Values were taken from Table 3.

(3 points) **ב.** Farmers add to the soil low concentrations of the compound ammonium hydroxide (NH_4OH), which contains the element nitrogen (N), because scientists have found that lack of nitrogen compounds in the soil slows plant growth. Suggest one explanation for the scientists' finding.

Give the proctor your exam paper and your notebook.

Good Luck!

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בהצלחה!

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אין להעתיק או לפרסם אלא ברשות משרד החינוך.

Practical Exam in Biology

בחינת בגרות מעשית בביולוגיה

Problem 5

בעיה 5

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

--	--	--	--	--	--	--	--	--

Instructions for examinees:

הוראות לנבחן:

א. Duration of the exam: Three hours

א. משך הבחינה: שלוש שעות.

ב. Material that may be used during the exam:

ב. חומר עזר מותר בשימוש:

- (1) Calculator
- (2) Hebrew-foreign language / foreign language-Hebrew dictionary

- (1) מחשבון.
- (2) מילון עברי-לועזי / לועזי-עברי.

ג. Special instructions:

ג. הוראות מיוחדות:

- (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 that you obtained, even if they are not as expected.

- (1) קרא את ההנחיות ביסודיות ושקול היטב את צעדיך.
- (2) רשום בעט את כל תצפיותיך ותשובותיך (גם סרטוטים).
- (3) בסס את תשובותיך על תצפיותיך ועל התוצאות שקיבלת, גם אם הן אינן תואמות את הצפוי.

Write in the exam booklet only. Write the word "טייטה" 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.

כתוב במחברת הבחינה בלבד. רשום "טייטה" בראש כל עמוד המשמש טייטה. כתיבת טייטה בדפים שאינם במחברת הבחינה עלולה לגרום לפסילת הבחינה.

Good Luck!

בהצלחה!

Problem 5

In this problem, you will examine the effect of different alkaline solutions on the pH inside plant cells.

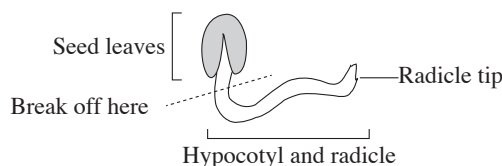
The questions in this exam are numbered **49-60**. The point value of each question is given on the left. Answer all of the questions in your notebook.

Part α — Learn a method for testing pH in cowpea [לוביה] radicle cells

I. Preparing radicles [שורשונים]

- א. On your table is a plate marked "נבטים" [seedlings] with cowpea seedlings. You will have to separate each radicle from the rest of the seedling's parts (see Figure 1) so that you have 23 radicles of similar length. Do it as follows:
- ב. Select 23 seedlings with radicles of similar length, and place them on the plate lined with a damp paper towel and marked "שורשונים".
- ג. Detach the cotyledons (seed leaves) [פסיגים] from all the seedlings on the "שורשונים" plate (see Figure 1). Discard the cotyledons into the waste container.

Figure 1: Cowpea seedling



Note: In this experiment, the remaining parts of the seedlings (hypocotyl [תת-פסיג] and radicle) are referred to together as the 'radicle'.

You will later be placing these radicles in soaking solutions.

— Transfer the "נבטים" plate and the seedlings it contains to the waste container.

II. Learn about the indicator's properties; learn a method for testing penetration of substances into cells

You have a container with a solution of ammonium hydroxide [בסיס האמוניום] (NH_4OH); a container with a neutral red solution ["אדום ניטרלי"]; and a container with water for the experiment ["מים לניסוי"], which is water with a pH that has been adjusted for this experiment.

Informative Note 1: The solution of neutral red serves as an acid-base indicator [חומר בוחן]: In an acidic [חומצית] environment the solution is red, and in an alkaline [בסיסית] environment it is orange.

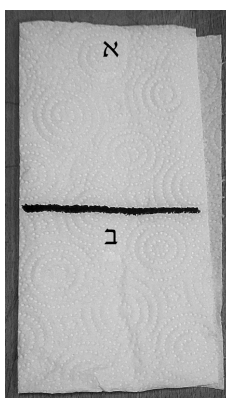
- ד. Mark one test tube "מים לניסוי" [water for experiment] and one test tube "בסיס" [base].
- Mark a 5 ml pipette "מים" and use it to transfer 5 ml of "מים לניסוי" to the test tube marked "מים לניסוי".
 - Mark a 10 ml pipette "בסיס האמוניום" [ammonium hydroxide] and use it to transfer 5 ml of ammonium hydroxide solution to the test tube marked "בסיס".
- ה. You have a pipette marked "אדום ניטרלי לחלק א" [neutral red for Part א] which has been marked with a white line indicating a volume of 2.5 ml.
- Use the pipette to add 2.5 ml of neutral red solution to each of the test tubes "מים לניסוי" and "בסיס".
- Cap the test tubes and shake them gently to mix the liquids.
 - Look at the color of the solutions in your test tubes. Determine whether the color in each test tube is red or orange.
- Solution color in the "מים לניסוי" test tube: _____;
- solution color in the "בסיס" test tube: _____.
- ו. You have some small beakers. Mark an "א" under the rim of a small beaker and prepare a soaking solution in it, as follows:
- Use the "מים" pipette to transfer 5 ml of "מים לניסוי" to Beaker א.
- Use the "אדום ניטרלי לחלק א" pipette to transfer 2.5 ml of neutral red solution to Beaker א. Gently shake the beaker to mix the liquids.
 - Write down the color of the soaking solution in Beaker א: _____.

- ז. Place 4 radicles (from the "שורשונים" plate) in the soaking solution in Beaker א. Make sure the radicles are covered in solution. If necessary, use tweezers to push the radicles down into the solution.
- Wipe the tips of the tweezers with a paper towel.
 - Write down the time: _____ and wait 5 minutes. While you are waiting perform Items ח and ט.
- Your experiment results will not be affected if soaking continues longer than 5 minutes.

Informative Note 2: The neutral red indicator can pass through the membrane of living cells and does not affect processes in the cells.

- ח. Mark a small beaker "ב".
- Use the "בסיס האמוניום" pipette to transfer 5 ml of ammonium hydroxide solution to Beaker ב.
- ט. Fold a paper towel in half to make a double layer.
- Use a glass marking pen to draw a line through the middle of the folded paper towel. Mark an "א" on the top part of the paper towel and a "ב" under the line (see Figure 2).

Figure 2: Marking the folded paper towel



- י. About 5 minutes after the time you recorded in Item ז, use the tweezers to carefully remove all the radicles from Beaker א and place them on the paper towel, close to the א marking.
- Move the radicles from the wet area to a dry area on Area א of the paper towel where there is no dye residue.
 - Wipe the tips of the tweezers with a paper towel.

Answer Question **49.א.**

(4 points) **49.א.** Copy the following sentences **(1)-(3)** to your notebook.

In **your notebook**, circle the correct option in each of the sentences, basing your answer on the color of the radicle **tips** in front of you (see Figure 1), the information in Informative Notes 1 and 2, and the results you recorded in Items ה and ו.

- (1)** The pH of the soaking solution in Beaker א is: acidic / alkaline.
- (2)** The color of the radicle tips after soaking in water for the experiment (Beaker א) is: red / orange.
- (3)** The pH of the solution **inside the radicle tip cells** after soaking in Beaker א is: acidic / alkaline.

א. Use the tweezers to gently transfer 2 radicles from Area א on the paper towel to Beaker ב, which contains ammonium hydroxide solution.

— Write down the time _____ and wait 3 minutes.

ב. 3 minutes after the time you recorded in Item א, use the tweezers to gently remove the radicles from Beaker ב and place them on the paper towel close to the ב marking.

- Move the radicles from the wet area to a dry area on Area ב of the paper towel where there is no dye residue.
- **Immediately** determine whether, after soaking in the ammonium hydroxide solution (Beaker ב), the tips of the radicles are red or orange: _____.
- Wipe the tips of the tweezers with a paper towel.

Note: If the tips of the radicles you took out of both beakers are all the same color, tell the proctor.

Answer Questions **49.ב-50.**

(5 points) **49.ב.** Copy the following sentences **(1)-(4)** to your notebook.

In **your notebook**, circle the correct option in each of the sentences, basing your answer on the information in Informative Notes 1 and 2, and the results you recorded in Items ה and ו.

- (1)** The pH of the soaking solution in Beaker א is: acidic / alkaline.
- (2)** The color of the radicle tips after soaking in an ammonium hydroxide solution (Beaker א) is: orange / red.
- (3)** The pH of the solution **inside the radicle tip cells** after soaking in Beaker א is: acidic / alkaline.
- (4)** Ammonium hydroxide penetrated / did not penetrate the radicle tip cells.

(4 points) **50. א. Explain** how you checked whether ammonium hydroxide had penetrated the radicle cells.

(2 points) **ב.** Is the method you used to test whether ammonium hydroxide had penetrated the radicle tip cells quantitative or qualitative? Explain.

- Transfer the paper towel marked א and ב, the radicles left on it, the pipette "אדום ניטרלי לחלק א", Beakers א and ב, and the solutions they contain into the waste container.

Part ב — Testing the effect of pre-treating radicles with an ethanol solution on penetration of different alkaline solutions into radicle cells

- יג. You have a covered container with an ethanol solution.

Informative Note 3: Ethanol (alcohol) is a substance that dissolves fats.

- Use the tweezers to transfer 10 radicles from the "שורשונים" plate to the ethanol container. Make sure that the radicles are completely covered by the solution. If necessary, use the tweezers to push the radicles down into the solution.
- Cover the container with its lid.
- Write down the time: _____, and wait 10 minutes.
- While you are waiting perform items טז-יז.

Your experiment results will not be affected if soaking continues longer than 10 minutes.

- יד. Mark 6 small beakers (near the top) with the numbers 1-6.

- Mark one pipette "בסיס האשלגן" [potassium hydroxide] and another pipette "בסיס הנתרן" [sodium hydroxide]. You also have a "בסיס האמוניום" pipette which you already marked in Part א.

- טו. You have three containers, and each one contains a different alkaline solution: potassium hydroxide (KOH), ammonium hydroxide, sodium hydroxide (NaOH).

The concentration of all the solutions is **0.01M**.

Using the corresponding pipettes, transfer solutions to the beakers as follows:

- in Beakers **1, 2**, put 7 ml of potassium hydroxide solution
- in Beakers **3, 4**, put 7 ml of ammonium hydroxide solution
- in Beakers **5, 6**, put 7 ml of sodium hydroxide solution.

- טז. You have the "אדום ניטרלי לחלק ב" pipette marked with a white line indicating a volume of 3 ml. Use this pipette to withdraw neutral red solution up to the marked line, and put this solution in Beaker 1.

- Using the same method, add 3 ml of neutral red solution to each of the beakers 2-6.
- Gently shake each beaker to mix the liquids it contains.

- יז. About 10 minutes after the time you recorded in Item יג, use the tweezers to take all the radicles out of the ethanol.

Place them on a dry paper towel and gently dab off any remaining liquid.

- Wipe the tips of the tweezers with a paper towel.
- Cover the ethanol container and give it to the proctor.

- יה. Transfer 3 radicles that were soaked in ethanol to each of the beakers **1, 3, 5**.
- Transfer 3 radicles that were **not** soaked in ethanol solution (of the ones left on the "שורשונים" plate) into each of the beakers **2, 4, 6**.
 - Make sure that the radicles are completely covered by the solution. If necessary, use the tweezers to push the radicles down into the solution. Wipe the tips of the tweezers every time you dip them in a cup.
 - Write down the time: _____, and wait 10 minutes.
 - While you are waiting, answer Question **51.א.** and perform Item יט.
- Your experiment's results will not be affected if the soaking continues for longer than 10 minutes.

Answer Question **51.א.**

- (4 points) **51.א.** In your notebook, prepare Table 1 to summarize the experiment set-up that you ran in Part ב (solutions 1-6). Include 4 **additional** empty columns in your table.

Note: Draw the table across the length of the page to allow more space and clarity.

- יט. You have 3 paper towels. Fold each one in half and place them side by side on the table. Draw a line through the middle of each one (see Figure 2).
- Mark the top of one paper towel "1" and the bottom half under the line "2". Mark a second paper towel "3" and "4", and a third paper towel "5" and "6", in the same way.
- כ. About 10 minutes after the time you recorded in Item יה, use the tweezers to carefully remove all the radicles from the soaking solution in Beaker 1, and place them on the paper towel close to the "1" mark.
- Move the radicles from the wet area to a dry area on Area 1 of the paper towel where there is no dye residue.
 - **Immediately** determine whether the color of the tips of the radicles from the soaking solution in Beaker 1 is red or orange: _____.
- Note: If the three radicle tips that were soaked in the same solution are not all the same color, record the color of two radicle tips that have a similar color.
- Wipe the tips of the tweezers with a paper towel.
- כא. Repeat Item כ with the radicles in Beakers 2-6 and the corresponding areas of the paper towels.
- **Immediately** determine whether the color of the radicle tips from the soaking solutions in each of the beakers is red or orange.
- Beaker 2: _____
- Beaker 3: _____
- Beaker 5: _____
- Beaker 4: _____
- Beaker 6: _____

Answer Questions **51.ג.-57.**

- (6 points) **51.ג.** (1) Write down the color of the soaking solutions in Beakers 1-6 in an empty column in Table 1 in **your notebook**.
- (2) Based on the color of the solution in each of the beakers 1-6, determine whether the pH of the soaking solution is acidic or alkaline. Write down your answers in the appropriate spaces in another empty column in Table 1 in **your notebook**.
- (4 points) **52.א.** Write down the results in an empty column in Table 1 in **your notebook**: the color of the tips of the radicles soaked in each of the solutions 1-6 (Items ג and ד).
- (4 points) **ג.** Based on the results you recorded in Item א, determine whether, at the end of the experiment, the pH in the cells of radicle tips soaked in Beakers 1-6 is acidic or alkaline. Write down your answers in the appropriate spaces in an empty column in Table 1 in **your notebook**.
- (5 points) **53.א.** What are the independent variables in the experiment you conducted?
- (5 points) **ג.** Give your table a title and suitable column headings.
- (4 points) **54.א.** Based on the results of the experiment with the radicles soaked in Beakers 2, 4, and 6, determine for each of the bases whether it **did or did not** penetrate the radicle tip cells.
- Which results support your answers?
- (4 points) **ג.** Based on the results of the experiment with the radicles soaked in Beakers 1 and 2, is it correct to conclude that the result for the radicles soaked in Beaker 1 was affected by the ethanol solution and not by the type of alkaline solution? Explain.
- (4 points) **55.א.** Based on the results of the experiment with the radicles soaked in Beakers 1, 3, and 5, what can you conclude about the effect of soaking the radicles in ethanol on the penetration of the bases into the radicle tip cells? Specify which results support your conclusion.
- (4 points) **ג.** Use the information in Informative Note 3 to suggest a possible explanation for the effect of pre-soaking in ethanol on penetration of the bases into the radicle tip cells.

(2 points) **56. א.** Calculate the final concentration of each of the base solutions in Beakers 1-6 which you prepared (Items טו and טז).

Note: The final volume of each of the solutions is 10 ml.

(4 points) **ב.** Explain how the temperature of the soaking solution might affect penetration of the base into the radicle cells.

(2 points) **ג.** The temperature of the soaking solutions in the experiment set-up you ran in Part ב is a:

- i control
- ii dependent variable
- iii method for testing the dependent variable
- iv constant factor

Copy the correct answer to **your notebook**.

57. Students conducted an experiment like the one you ran in Part א. They noticed that the color of the radicle tips soaked in Beaker ב (ammonium hydroxide) and then placed on the paper towel changed after some time to a color similar to the color of the radicle tips soaked in Beaker א.

The students proposed an explanation: The color changed due to the respiration process in the radicle cells.

(5 points) **א.** Explain how the process of respiration can affect the change in color of the radicle cells.

(3 points) **ב.** The following measures, i-ii, can be used to test whether respiration is taking place inside the radicle cells in the soaking solution:

- i amount of oxygen in the solution at the end of the experiment
- ii temperature of the solution at the end of the experiment

Choose one of these measures and specify which result would be evidence of respiration inside the radicle cells: an **increase** or a **decrease** in this measure. Explain your answer.

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

Part 3 — Analysis of research results: Effect of pH in an external solution on the internal pH of plant cells

Researchers were interested in the effect of the pH of an external solution on the pH of the cytoplasm of plant cells.

Earlier studies showed that the pH in the cytoplasm of plane tree [דולב] leaves remains a constant 7.4-7.5.

The researchers took some plane tree leaves and cultured them in solution under optimal conditions. The solution contained dissolved oxygen and other substances that are essential to cells. The pH of this solution was 6.5.

Several hours later the researchers divided the solution and the cells it contained into 7 containers. In each container they created a culture solution with a different pH and kept the pH constant throughout the experiment.

After 4 hours, the researchers measured the pH in the cytoplasm of the cells in each of the containers.

Their results are shown in Table 2, below.

Table 2

pH in the culture solution	pH in the cytoplasm after 4 hours
3.5	6.5
4.0	7.0
4.5	7.5
6.0	7.5
7.5	7.5
8.0	8.0
9.5	8.5

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

Answer Questions **58-60**.

- (3 points) **58. א.** What type of graphical representation is most suited to describing the results shown in Table 2, a continuous graph or a bar diagram? Explain your answer.
- (6 points) **ב.** **In your notebook**, use the type of graphical representation you chose in Item א to present the experimental results shown in Table 2.
- (4 points) **59. א.** Under optimal conditions, the constant pH in the cytoplasm of cells of plane tree leaves is 7.4-7.5.
Based on the results, determine at what pH levels in the **culture solution** is the cytoplasm pH higher than 7.5 and at what pH levels in the **culture solution** is the cytoplasm pH lower than 7.4.
- (5 points) **ב.** Explain the importance of maintaining a constant pH in the cytoplasm.
- (4 points) **60. א.** During the experiment described in Part א, the researchers also tested oxygen consumption rates in the cells.
During the tested interval, the number of cells did not increase.
Some of their results are shown in Table 3, below.
Suggest a possible explanation for the difference in rate of oxygen consumption between Treatment 1 and Treatment 2.

Table 3

	Treatment	Results	
	pH in culture solution*	pH in cytoplasm*	Oxygen consumption rate (micromole/minute/gram of leaf)
1	4.5	7.5	0.50
2	7.5	7.5	0.30

*Values were taken from Table 2.

- (3 points) **ב.** Farmers add to the soil low concentrations of the compound ammonium hydroxide (NH_4OH), which contains the element nitrogen (N), because scientists have found that lack of nitrogen compounds in the soil slows plant growth. Suggest one explanation for the scientists' finding.

Give the proctor your exam paper and your notebook.

Good Luck!

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בהצלחה!

זכות היוצרים שמורה למדינת ישראל.
אין להעתיק או לפרסם אלא ברשות משרד החינוך.

Practical Exam in Biology

בחינת בגרות מעשית בביולוגיה

Problem 6

בעיה 6

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

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Instructions for examinees:

הוראות לנבחן:

א. Duration of the exam: Three hours

א. משך הבחינה: שלוש שעות.

ב. Material that may be used during the exam:

ב. חומר עזר מותר בשימוש:

- (1) Calculator
- (2) Hebrew-foreign language / foreign language-Hebrew dictionary

- (1) מחשבון.
- (2) מילון עברי-לועזי / לועזי-עברי.

ג. Special instructions:

ג. הוראות מיוחדות:

- (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 that you obtained, even if they are not as expected.

- (1) קרא את ההנחיות ביסודיות ושקול היטב את צעדיך.
- (2) רשום בעט את כל תצפיותיך ותשובותיך (גם סרטוטים).
- (3) בסס את תשובותיך על תצפיותיך ועל התוצאות שקיבלת, גם אם הן אינן תואמות את הצפוי.

Write in the exam booklet only. Write the word "טייטה" 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.

כתוב במחברת הבחינה בלבד. רשום "טייטה" בראש כל עמוד המשמש טייטה. כתיבת טייטה בדפים שאינם במחברת הבחינה עלולה לגרום לפסילת הבחינה.

Good Luck!

בהצלחה!

Problem 6

In this problem, you will examine the effect of different alkaline solutions on the pH inside plant cells.

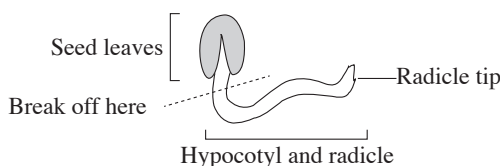
The questions in this exam are numbered **61-72**. The point value of each question is given on the left. Answer all of the questions in your notebook.

Part א — Learn a method for testing pH in cowpea radicle cells [תאי שורשון של נבט לוביה]

I. Preparing radicles [שורשונים]

- א. On your table is a plate labeled "נבטים" [seedlings] with cowpea seedlings. You will have to separate each radicle [שורשון] from the rest of the seedling's parts (see Figure 1) so that you have 22 radicles of similar length. Do as follows:
- ב. Select 22 seedlings with radicles of similar length, and place them on a plate lined with a damp paper towel and labeled "שורשונים".
- ג. Detach the cotyledons (seed leaves) [פסיגים] from all the seedlings on the "שורשונים" plate (see Figure 1). Discard the cotyledons in the waste container.

Figure 1: Cowpea seedling



Note: In this experiment, the remaining parts of the seedlings (hypocotyl [תת-פסיג] and radicle) are referred to together as the 'radicle'.

Later, you will be placing these radicles in soaking solutions.

— Transfer the "נבטים" plate and the seedlings it contains to the waste container.

II. Learn about the indicator's properties; learn a method for testing penetration of substances into cells

You have a container with a solution of ammonium hydroxide [בסיס האמוניום] (NH_4OH); a container with a neutral red solution ["אדום ניטרלי"]; and a container with water for the experiment ["מים לניסוי"], which is water with a pH that has been adjusted for this experiment.

Informative Note 1: The solution of neutral red serves as an acid-base indicator [חומר בוחן]: In an acidic [חומצי] environment the solution is red, and in an alkaline [בסיסי] environment it is orange.

- ד. Mark one test tube "מים לניסוי" [water for experiment] and one test tube "בסיס" [base].
- Mark a 10 ml pipette "מים" and use it to transfer 5 ml of "מים לניסוי" to the test tube marked "מים לניסוי".
 - Mark a 5 ml pipette "בסיס האמוניום" [ammonium hydroxide] and use it to transfer 5 ml of ammonium hydroxide solution to the test tube marked "בסיס".
- ה. You have a pipette marked "אדום ניטרלי" [neutral red] which has been marked with a white line indicating a volume of 2.5 ml and an additional white line indicating a volume of 5 ml. Use the pipette to add 2.5 ml of neutral red solution to each of the test tubes "מים לניסוי" and "בסיס".
- Cap the test tubes and shake them gently to mix the liquids.
 - Look at the color of the solutions in your test tubes. Determine whether the color in each test tube is red or orange.
- Solution color in the "מים לניסוי" test tube: _____;
- solution color in the "בסיס" test tube: _____.
- ו. You have some small beakers. Mark an "א" under the rim of a small beaker and prepare a soaking solution in it, as follows:
- Use the "מים" pipette to transfer 5 ml of "מים לניסוי" to Beaker א.
- Use the "אדום ניטרלי" pipette to transfer 2.5 ml of neutral red solution to Beaker א.
- Gently shake the beaker to mix the liquids.
- Write down the color of the soaking solution in Beaker א: _____.
- ז. Place 4 radicles (from the "שורשונים" plate) in the soaking solution in Beaker א. Make sure the radicles are covered in solution. If necessary, use tweezers to push the radicles down into the solution.
- Wipe the tips of the tweezers with a paper towel.
 - Record the time: _____ and wait 5 minutes. While you are waiting, perform Items ח and ט.

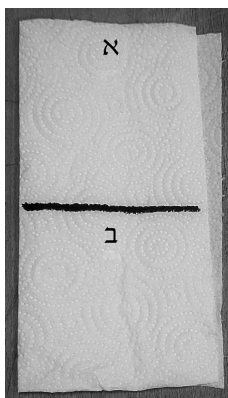
Your experiment results will not be affected if soaking continues longer than 5 minutes.

/continued on page 4/

Informative Note 2: The neutral red indicator can pass through the membrane of living cells and does not affect processes in the cells.

- ח. Mark a small beaker "ב".
- Use the "בסיס האמוניום" pipette to transfer 5 ml of ammonium hydroxide solution to Beaker ב.
- ט. Fold a paper towel in half to make a double layer.
- Use a glass marking pen to draw a line through the middle of the folded paper towel. Mark an "א" on the top part of the paper towel and a "ב" under the line (see Figure 2).

Figure 2: Marking the folded paper towel



- י. About 5 minutes after the time you recorded in Item ט, use the tweezers to carefully remove all the radicles from Beaker א and place them on the paper towel close to the א marking.
- Move the radicles from the wet area to a dry area on Area א of the paper towel where there is no dye residue.
 - Wipe the tips of the tweezers with a paper towel.

Answer Question **61.א.**

(4 points) **61.א.** Copy the following sentences (1)-(3) to your notebook.

In **your notebook**, circle the correct option in each of the sentences, basing your answer on the color of the radicle **tips** in front of you (see Figure 1), the information in Informative Notes 1 and 2, and the results you recorded in Items ה and ו.

- (1) The pH of the soaking solution in Beaker א is: acidic / alkaline.
- (2) The color of the radicle tips after soaking in water for the experiment (Beaker א) is: red / orange.
- (3) The pH of the solution **inside the radicle tip cells** after soaking in Beaker א is: acidic / alkaline.

/continued on page 5/

- יא. Use the tweezers to gently transfer 2 radicles from Area א on the paper towel to Beaker ב, which contains ammonium hydroxide solution.
- Record the time _____ and wait 3 minutes.
- יב. 3 minutes after the time you recorded in Item יא, use the tweezers to gently remove the radicles from Beaker ב, and place them on the paper towel close to the ב marking.
- Move the radicles from the wet area to a dry area on Area ג of the paper towel where there is no dye residue.
 - **Immediately** determine whether, after soaking in the ammonium hydroxide solution (Beaker ב), the tips of the radicles are red or orange: _____.
 - Wipe the tips of the tweezers with a paper towel.
- Note: If the tips of the radicles you took out of both beakers are the same color, ask the proctor for help.

Answer Questions 61.ג-62.

(5 points) 61.ג. Copy the following sentences (1)-(4) to your notebook.

In **your notebook**, circle the correct option in each of the sentences, basing your answer on the information in Informative Notes 1 and 2, and the results you recorded in Items ה and ו.

- (1) The pH of the soaking solution in Beaker ג is: acidic / alkaline.
- (2) The color of the radicle tips after soaking in an ammonium hydroxide solution (Beaker ג) is: orange / red.
- (3) The pH of the solution **inside the radicle tip cells** after soaking in Beaker ג is: acidic / alkaline.
- (4) Ammonium hydroxide penetrated / did not penetrate the radicle tip cells.

(4 points) 62.א. **Explain** how you tested whether ammonium hydroxide had penetrated the radicle tip cells.

(2 points) ג. Is the method you used to test whether ammonium hydroxide had penetrated the radicle tip cells quantitative or qualitative? Explain.

- Transfer the paper towel marked א and ב, the radicles left on it, Beakers א and ב, and the solutions they contain into the waste container.

Part ב — Testing penetration of sodium hydroxide solutions of different concentrations into radicle cells

- יג. Mark 6 small beakers (near the top) with the numbers 1-6.
- You have a container with sodium hydroxide [בסיס נתרן] (NaOH) solution of **0.1M** concentration and the pipette "מים" that you labeled in Part א.
- Mark a pipette "בסיס הנתרן", and add "מים לניסוי" and sodium hydroxide solution to each of the beakers as specified in Table 1 below.

Table 1

Beaker	Volume of "מים לניסוי" (ml)	Volume of 0.1M sodium hydroxide solution (ml)	Final concentration of sodium hydroxide solution (M)
1	0	10	
2	2	8	
3	4	6	
4	6	4	
5	8	2	
6	9	1	

- יד. Calculate the concentrations of the alkaline solutions that you prepared in Beakers 1-6, and write down the results of your calculations in the appropriate places in Table 1.
- טו. Use your "אדום ניטרלי" pipette to withdraw neutral red solution up to the white line indicating 5 ml, and add this solution to Beaker 1.
- Using the same method, add 5 ml neutral red solution to each of Beakers 2-6.
 - Gently shake each beaker to mix the liquids it contains.
- טז. Transfer 3 radicles from the "שורשונים" plate to each of Beakers 1-6. Make sure that the radicles are completely covered by the solution. If necessary, use the tweezers to push the radicles down into the solution. Wipe the tips of the tweezers every time you dip them in a cup.
- Record the time: _____, and wait 10 minutes.
 - While you are waiting, answer Question 63.א. and perform Item יז.
- Your experiment's results will not be affected if the soaking continues for longer than 10 minutes.

Answer Question **63.א.**

(6 points) **63.א.** In your notebook, prepare Table 2 and summarize in it the experiment set-up that you ran in Part ב (with the solutions 1-6). Include 4 **additional** empty columns in your table.

Note: Draw the table across the length of the page to allow more space and clarity.

- יז. You have 3 paper towels. Fold each one in half and place them side by side on the table. Draw a line through the middle of each one (see Figure 2).
- Mark the top of one paper towel "1" and the bottom half, under the line, "2". Mark a second paper towel "3" and "4", and a third paper towel "5" and "6", in the same way.
- יח. About 10 minutes after the time you recorded in Item יז, use the tweezers to carefully remove all the radicles from the soaking solution in Beaker 1, and place them on the paper towel close to the "1" mark.
- Move the radicles from the wet area to a dry area on Area 1 of the paper towel where there is no dye residue.
 - **Immediately** determine whether the color of the tips of the radicles from the soaking solution in Beaker 1 is red or orange: _____.
- Note: If the three radicle tips that were soaked in the same solution are not the same color, record the color of two radicle tips that have a similar color.
- Wipe the tips of the tweezers with a paper towel.
- יט. Repeat Item יח with the radicles in Beakers 2-6 and the corresponding areas of the paper towels.
- **Immediately** determine whether the color of the radicle tips from the soaking solutions in each of the beakers is red or orange.
- Beaker 2: _____
- Beaker 3: _____
- Beaker 5: _____
- Beaker 4: _____
- Beaker 6: _____

Answer Questions **63.ג.-69.**

- (6 points) **63.ג.** (1) Write down the colors of the soaking solutions in Beakers 1-6 in an empty column in Table 2 in **your notebook**.
- (2) Based on the color of the solution in each of the beakers 1-6, determine whether the pH of the soaking solution is acidic or alkaline.
Write down your answers in the appropriate spaces in another empty column in Table 2 in **your notebook**.
- (4 points) **64.א.** Write down the results in an empty column in Table 2 in **your notebook**: the color of the tips of the radicles soaked in each of the solutions 1-6 (Items יח and יט).
- (4 points) **ג.** Based on the results you recorded in Item א, determine whether, at the end of the experiment, the pH in the cells of radicle tips soaked in Beakers 1-6 is acidic or alkaline. Write down your answers in the appropriate spaces in an empty column in Table 2 in **your notebook**.
- (5 points) **ג.** Give headings to the columns in the table, and give an appropriate title to the entire table.
- (4 points) **65.א.** Based on the results of the experiment in Part ג, determine the sodium hydroxide solution concentrations at which the sodium hydroxide penetrated into the radicle tip cells. Specify which results support your conclusions.
- (4 points) **ג.** Suggest an explanation for the effect of the sodium hydroxide solution concentration on penetration of the hydroxide into the radicle tip cells.
- (4 points) **66.א.** You are to compare the penetration of **ammonium hydroxide** (Beaker ג from Part א) into the radicle tip cells with the penetration of **sodium hydroxide** (in Part ג) into these cells.
Which of the beakers 1-6 in Part ג will you choose for the comparison?
Explain.
Note: Ignore the volume of neutral red solution that you added to the beakers.
- (4 points) **ג.** What can you learn from this comparison about the penetration of each of these bases into the radicle cells?

(4 points) **67. א.** Explain how the temperature of the soaking solution might affect penetration of the base into the radicle cells.

(2 points) **ב.** The temperature of the soaking solutions in the experiment set-up you ran in Part ב is a:

- i constant factor
- ii control
- iii dependent variable
- iv method for testing the dependent variable

Copy the correct answer to **your notebook**.

(5 points) **68.** Students conducted an experiment like the one you ran in Part ב to investigate the penetration of three types of bases (sodium hydroxide, ammonium hydroxide, and potassium hydroxide).

They prepared 6 solutions of each of these bases, each one with a different concentration, and checked the penetration of each of the solutions into the radicle cells.

What were the independent variables in the students' experiment?

69. Students conducted an experiment like the one you ran in Part א. They noticed that the color of the radicle tips soaked in Beaker ב (ammonium hydroxide) and then placed on the paper towel changed after some time to a color similar to the color of the radicles tips soaked in Beaker א.

The students proposed an explanation: The color changed due to the respiration process in the radicle cells.

(5 points) **א.** Explain how the process of respiration can affect the change in color of the radicle cells.

(3 points) **ב.** The following measures, i-ii, can be used to test whether respiration is taking place inside the radicle cells in the soaking solution:

- i the amount of oxygen in the solution at the end of the experiment
- ii the temperature of the solution at the end of the experiment

Choose one of these measures and specify which result would be evidence of respiration inside the radicle cells: an **increase** or a **decrease** in this measure.

Explain your answer.

Part 3 — Analysis of research results: Effect of pH of an external solution on the internal pH of plant cells

Researchers were interested in the effect of the pH of an external solution on the pH of the cytoplasm of plant cells.

Earlier studies showed that the pH in the cytoplasm of plane tree [דולב] leaf cells remains a constant 7.4-7.5.

The researchers took some plane tree leaf cells and cultured them in solution under optimal conditions. The solution contained dissolved oxygen and other substances that are essential to cells. The pH of this solution was 6.5.

Several hours later the researchers divided the solution and the cells it contained into 7 containers. In each container they created a culture solution with a different pH and kept this pH constant throughout the experiment.

After 4 hours, the researchers measured the pH in the cytoplasm of the cells in each of the containers.

Their results are shown in Table 3, below.

Table 3

pH in the culture solution	pH in the cytoplasm after 4 hours
3.5	6.5
4.0	7.0
4.5	7.5
6.0	7.5
7.5	7.5
8.0	8.0
9.5	8.5

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

Answer Questions **70-72**.

- (3 points) **70.א.** What type of graphical representation is most suitable for describing the results shown in Table 3, a continuous graph or a bar diagram? Explain your answer.
- (6 points) **ב.** **In your notebook**, use the type of graphical representation you chose in Item א to present the experimental results shown in Table 3.
- (4 points) **71.א.** Under optimal conditions, the constant pH in the cytoplasm of plane tree leaf cells is 7.4-7.5.
 Based on the results, determine at what pH levels in the **culture solution** is the cytoplasm pH higher than 7.5 and at what pH levels in the **culture solution** is the cytoplasm pH lower than 7.4.
- (5 points) **ב.** Explain the importance of maintaining a constant pH in the cytoplasm.
- (4 points) **72.א.** During the experiment described in Part א, the researchers also tested oxygen consumption rates in the cells.
 During the tested interval, the number of cells did not increase.
 Some of their results are shown in Table 4, below.
 Suggest a possible explanation for the difference in rate of oxygen consumption between Treatment 1 and Treatment 2.

Table 4

	Treatment	Results	
	pH in culture solution*	pH in cytoplasm*	Oxygen consumption rate (micromole/minute/gram of leaf)
1	4.5	7.5	0.50
2	7.5	7.5	0.30

*Values were taken from Table 3.

- (3 points) **ב.** Farmers add to the soil low concentrations of the compound ammonium hydroxide (NH_4OH), which contains the element nitrogen (N), because scientists have found that lack of nitrogen compounds in the soil slows plant growth. Suggest one explanation for the scientists' finding.

Give the proctor your exam paper and your notebook.

Good Luck!

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