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מדינת ישראל
משרד החינוך
סוג הבחינה: בגרות
מועד הבחינה: קיץ תשפ"ג, 2023
מספר השאלון: 43386
תרגום לאנגלית (3)

Practical Exam in Biology

בחינת בגרות מעשית בביולוגיה

Problem 1

בעיה 1

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

Instructions:

א. Duration of the exam: Three hours

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

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

הוראות:

א. משך הבחינה: שלוש שעות.

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

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

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

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

Good Luck!

בהצלחה!

Problem 1

In this problem, you will be testing the activity of the urease enzyme in soy seeds.

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

Answer all of the questions in your answer booklet.

Part א – Testing for the presence of proteins in soy seeds

In this part of the exam, you will be testing for the presence of proteins in soy seeds.

You will conduct the test using two solutions: a basic solution of sodium hydroxide (NaOH), which is colorless and a solution of copper sulfate ($CuSO_4$), which is light blue. In the presence of a mixture of these two solutions, the color of a liquid that contains proteins will change to purple.

On the table, you have:

- a mortar and pestle; the mortar contains 5 swollen soy seeds
- a test tube containing boiled soy filtrate, labeled "תסנין מורתח"
- a container of distilled water labeled "מים מזוקקים"
- a basic solution of sodium hydroxide (NaOH). Caution! Avoid skin contact with this basic solution.
- a 2% solution of copper sulfate ($CuSO_4$)
- a spoon

Put on the gloves and safety goggles.

Step א1: Preparing swollen soy seeds filtrate

א. Use a glass marking pen to write "תסנין" [filtrate] on an empty test tube.
Mark a line on the test tube, 10 cm from the bottom of the test tube.

ב. On the table, you have a funnel and a folded piece of gauze. Line the funnel with the piece of gauze and insert the tip of the funnel into the test tube labeled "תסנין".
Place the test tube in the test tube rack.

ג. Use the pestle to slightly crush the seeds in the mortar.
- Write "מים" on a 10 ml pipette, and use this pipette to add 10 ml of water to the mortar from the container labeled "מים מזוקקים".
- Crush the seeds for about two minutes.

ד. Add another 10 ml of water to the mortar and crush for one more minute until you have a pulp.
- Use the spoon to transfer all the pulp and liquid from the mortar to the gauze in the funnel, and wait until a filtrate is obtained in the test tube.
- Gather the edges of the gauze and squeeze it to filter the remaining liquid into the test tube. The volume of filtrate should reach the line you marked on the test tube or above it.
- If the volume of the filtrate does not reach the line you marked on the test tube, squeeze the gauze again.

ה. Transfer the funnel and the gauze with the remaining seed residue to the mortar.

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Step א2: Testing the presence of proteins in soy seeds filtrate and in boiled filtrate

ו. There are three empty test tubes in the rack. Label them 1, 2, and 3.
These test tubes will be used to test for the presence of proteins in the solutions: Test Tube 1 to test the filtrate, Test Tube 2 to test the boiled filtrate, and Test Tube 3 to test water.

ז. Write "תסנין" on a 5 ml pipette.
- Use it to transfer 1 ml of filtrate from the "תסנין" test tube to Test Tube 1.

ח. Write "תסנין מורתח" on a 5 ml pipette.
- Use it to transfer 1 ml of boiled filtrate from the "תסנין מורתח" test tube to Test Tube 2.

ט. Use the pipette labeled "מים" to transfer 1 ml of distilled water to Test Tube 3.
- Add 5 drops of the basic NaOH solution to each of the three experimental test tubes, 1–3.
- Add 5 drops of the $CuSO_4$ solution to each of the three experimental test tubes.
- Mix the contents of each of the test tubes by shaking them gently, then check the color of the solution in each of the test tubes.

Answer Questions **1-3**.

(6 points) **1.** **Copy** the table below into your **answer booklet** and fill in the missing information. Determine whether proteins were present in the solutions, based on the information listed in the introduction to Part א.

Table 1: Testing for the presence of proteins in the solutions

Test tube	**Tested solution**	**Test result** (Color)	**Presence of proteins** (Yes/No)
1			
2			
3			

(3 points) **2.** Explain why the test you conducted in Test Tube 3 is important.

(4 points) **3.** Is it possible to determine the protein concentration in the soy filtrate in Test Tube 1, based on the test you conducted? Explain.

Place Test Tubes 1–3 in the waste container on your table.

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Part ב – Experiment: Testing the activity of the urease enzyme in soy seeds filtrate

The compound **urea** is a product of metabolic processes in living cells.

Various organisms (including the soy plant) contain the **urease** enzyme which catalyzes the breakdown of urea.

One of the products of urea breakdown is ammonia (NH_3) which, in an aqueous environment, combines with water and forms a basic substance: **ammonium hydroxide**.

Step ב1: Preparing dilutions of urea solution

On the table, you have:

- a test tube with urea solution labeled "1% אוראה"
- a dropper bottle containing the indicator "פנול אדום" [phenol red]
- a solution of hydrochloric acid (HCℓ). Caution! Avoid skin contact with the acid solution.
- a Pasteur pipette

י. Label 5 empty test tubes: א–ה.

– Write "אוראה" on a 1 ml pipette and use it to transfer urea solution to Test Tubes **ב–ה**, according to the information shown in Table 2 below.

Do not add urea solution to Test Tube א.

יא. Write "מים" on a 1 ml pipette and use it to transfer water to Test Tubes **א–ג**, according to the information shown in Table 2.

– Mix the contents of the test tubes by shaking them gently.

Table 2

Test Tube	**Volume of 1% urea solution** (ml)	**Volume of water** (ml)
א	0	1
ב	0.1	0.9
ג	0.3	0.7
ד	1	0
ה	1	0

Step ב2: Testing the activity of urease enzyme in the filtrate

יב. Use the pipette labeled "תסנין מורתח" to add 3 ml of **boiled** filtrate to Test Tube **ה**.

יג. **Cap** the "**תסנין**" test tube **tightly**, and mix the liquid in the test tube by turning the test tube upside-down twice.

– Use the "תסנין" pipette to add 3 ml of filtrate from the "תסנין" test tube to <u>each</u> of the four test tubes **א–ד**.

– Gently shake each of the test tubes and put them back in the test tube rack.

– Write down the time _____ and wait 3 minutes.

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While you are waiting, read Items יד–טו (without carrying out any action) and the information in the box labeled "Note 1".

יד. 3 minutes after the time you recorded in Item יג, add one drop of phenol red to each of the five test tubes א–ה, and gently shake the test tubes.

Note 1
In the experiment you are about to conduct, phenol red is an indicator that is red-pink in a basic environment and yellow-orange in an acidic environment.

טו. Based on the information provided in Note 1, write for each of the solutions in the test tubes א–ה whether it is basic or acidic:
Test Tube א _____, Test Tube ב _____, Test Tube ג _____, Test Tube ד _____, Test Tube ה _____ .

During the following steps of the experiment, you will use the solution of hydrochloric acid (HCℓ) that is on the table. The acid will react with the ammonium base that was formed in the solutions.

Note 2
The greater the amount of base formed in the solution, the greater the amount of acid required to neutralize the base and change the color of the phenol red indicator.

Read the instructions in Items יז–טז before you start carrying them out. You will have to **gradually** add drops of acid to each of the solutions in Test Tubes א–ה, and **count** the drops.
Work carefully and accurately.

טז. Write "חומצה" on the Pasteur pipette that is on the table.
- Take Test Tube **א** out of the test tube rack and use the Pasteur pipette to add one drop of the acid HCℓ. The color of the solution in the test tube will turn light yellow.
- Put Test Tube **א** back in the test tube rack.

יז. Take Test Tube **ב** out of the test tube rack. Add acid drop by drop to the test tube and shake the test tube after each drop. **Count the drops** until the solution in Test Tube ב remains a stable light yellow for 10 seconds – **the color should be as close as possible to the color of the solution in Test Tube א**. Put the test tube back in the test tube rack.
- Write how many drops you added into Test Tube ב: _____ drops.

Note: After you put the test tube back in the test tube rack, the solution in the test tube may change color. **Ignore** this change.

יח. Repeat the procedure described in Item יז with test tubes ג, ד, ה.
- Write how many drops you added to Test Tube ג: _____ drops,
  to Test Tube ד: _____ drops,
  to Test Tube ה: _____ drops.

You do not need gloves and safety goggles for the rest of the exam, so you can take them off now.

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Answer Questions **4–8**.

(6 points) **4.** **Calculate** the concentration of the urea solution in each of the test tubes א–ה after you added the filtrate (in Items יב–יג).

Note: The concentration of the urea solution that you used is 1 %, and the final volume in each test tube is 4 ml (do not include in your calculation the volume of phenol red that you added to the test tubes).

Write the results of your calculations in your answer booklet.

Provide detailed calculations for Test Tubes ב and ג only.

(13 points) **5.** **א.**
- Draw a table in which you will summarize the entire experiment setup you conducted in Part ב, as well as its results (Items יח–י).
- Add a column to the table and record in it the results of your calculation for the concentration of the urea solution (Question 4).
- In the appropriate place in the table, record the single drop that you added to Test Tube א (Item טז) .
- Copy into the table the results of the experiment that you recorded in Items יח–יז.

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

(6 points) **6.** **א.** Suggest an explanation for the results you obtained in Test Tubes ב–ד. Your explanation should also refer to the measurement method.

(3 points) **ב.** The treatment in Test Tube א is a control treatment. Explain why the control treatment in Test Tube א is important in this experiment.

(7 points) **7.** **א.** Based on the results of the test that you conducted in Part א and the result of the experiment in Test Tube ה (in Part ב), answer Sub-Items (1)–(2):

(1) Did boiling the filtrate affect the presence of proteins? Give an explanation based on the results.

(2) Did boiling the filtrate affect the activity of the urease enzyme? Give an explanation based on the results.

(4 points) **ב.** Would your answer to Sub-Item א(2) be the same regarding the effect of boiling on the activity of all enzymes in nature? Explain your answer.

(4 points) **8.** **א.** Below is a list of four of the components of the experiment that you conducted in Part ב. **Copy them into your answer booklet**. For each component write in your **answer booklet** whether it is an independent variable or a constant factor or a method for measuring the dependent variable.

Components of the experiment:

- the total volume of the solution in a test tube
- the number of drops of acid required for the phenol red to change color
- the filtrate concentration in Test Tubes א–ד
- the urea concentration in the experimental test tubes

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

(4 points) **ג.** The temperature of the solution in the test tubes is a constant factor in the experiment that you conducted. Explain why it was important to have this **specific** factor constant in the experiment that you conducted.

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יט. Read the passage below and circle the correct option (acidic or basic) in statements I–II.

A student conducted an experiment identical to the one you conducted. He added drops of acid (Item יח) to the solutions in Test Tubes ג–ד until the color of the solutions turned yellow.

I. The yellow color indicates that the environment is acidic/basic.

A few minutes later, the color of the solutions changed back to pink.

II. The pink color indicates that the environment is acidic/basic.

Answer Question **9**.

(2 points) **9. א.** What is the possible explanation for the color change that happened a few minutes later in the solutions in Test Tubes ג and ד?

Below are four suggested answers. Choose the correct answer and **copy only this answer** into your answer booklet.

- The enzyme was denatured in the acidic environment, and as a result the environment became basic.
- The enzyme continued to be active even in the acidic environment and its activity made the environment basic.
- The enzyme was denatured in the basic environment, and as a result the environment became acidic.
- The enzyme continued to be active even in the basic environment and its activity made the environment acidic.

(2 points) **ב.** Explain your answer.

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Part ג – Analyzing research results: The use of urea and a urease enzyme inhibitor in agriculture

The world's population is expected to continue to grow in the coming years. To provide food for the growing population, agricultural crop yield has to increase.

Agricultural activity sometimes harms the environment and it is important to try to reduce such damage.

Urea is an organic compound containing nitrogen atoms (N) that farmers add to the soil to increase crop yield.

Plants absorb nitrogen compounds – such as urea – from the soil. Plant cells use these compounds to build other organic compounds containing nitrogen, such as chlorophyll.

Answer Question **10.**

(2 points) **10. א.** List <u>two</u> additional organic compounds (other than urea and chlorophyll) that are found in plants and contain nitrogen atoms (N).

In a study conducted on different plots in a wheat field, researchers examined the effect of adding urea on crop yield.

In Plot 1, they examined how adding different amounts of urea to the soil affected the weight of a wheat grain crop.

The results of the experiment conducted in Plot 1 are presented in Table 3 below.

Table 3

Amount of urea (kg/area unit)	**Wheat grain crop** (ton/area unit)
0	2.5
30	2.7
60	3.5
90	3.8
120	4.0

(5 points) **ב.** Use the information about chlorophyll given in the introductory passage above to explain the results of the experiment in Plot 1.

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

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The urease enzyme (that you tested in Part ב) is also found in soil, and comes from bacteria and the tissue of dead plants.

The urease enzyme catalyzes the breakdown of urea into ammonia (NH_3). Due to the enzyme's activity, some of the urea added to the soil breaks down. When urea breaks down, ammonia gas is formed, some of which evaporates into the air under certain environmental conditions.

The substance NBPT inhibits the activity of the urease enzyme **in the soil**, and farmers add it to the soil when they add urea. NBPT does not usually damage plants.

In another plot in the wheat field (Plot 2), the researchers examined how adding NBPT to the urea added to the soil affects crop yield.

The results obtained from both plots (Plot 1 with urea only, and Plot 2 with both urea and NBPT) are presented in Table 4 below.

Table 4

	Wheat grain crop (ton/area unit)	
	Plot 1	Plot 2
Amount of urea (kg/area unit)	**Without NBPT**	**With added NBPT**
0	2.5	Not tested
30	2.7	3.0
60	3.5	4.0
90	3.8	4.3
120	4.0	4.6

Answer Question **11**.

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

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

Note: You do not need to include the value that is labeled "Not tested" in your graphical representation.

(6 points) **ב.** Describe the results of the experiment, based on your graphical representation.

(4 points) **ג.** Use the information given on this page to suggest an explanation for the results of the experiment in Plot 2 (with added NBPT).

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

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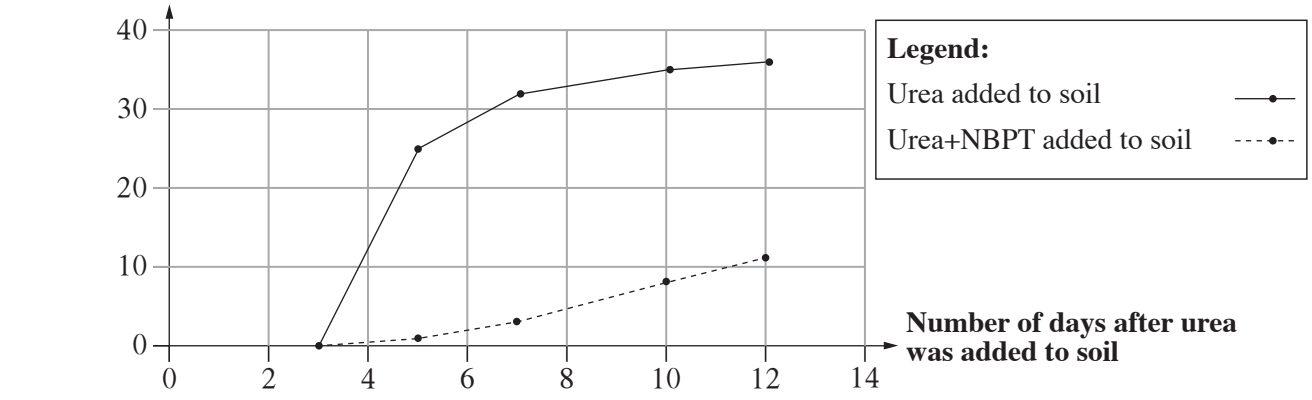
Ammonia gas can be harmful to human health, biodiversity, and various ecosystems. Therefore, many countries seek ways to reduce the amount of ammonia gas that evaporates into the air when urea in the soil breaks down.

In another study, researchers tested the amount of ammonia gas that evaporates into the air in two plots of land: in one plot they added urea, and in another plot they added both urea and NBPT.

The graph below shows the relative quantity of ammonia gas that evaporated into the air over 12 days in both plots.

Evaporation of ammonia gas from soil to which either only urea or urea+NBPT were added



Answer Question **12**.

(3 points) **12.** Use the results shown in the graph above to explain how adding NBPT to urea can affect the extent of damage to the environment caused by adding urea to the soil.

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

Good Luck!