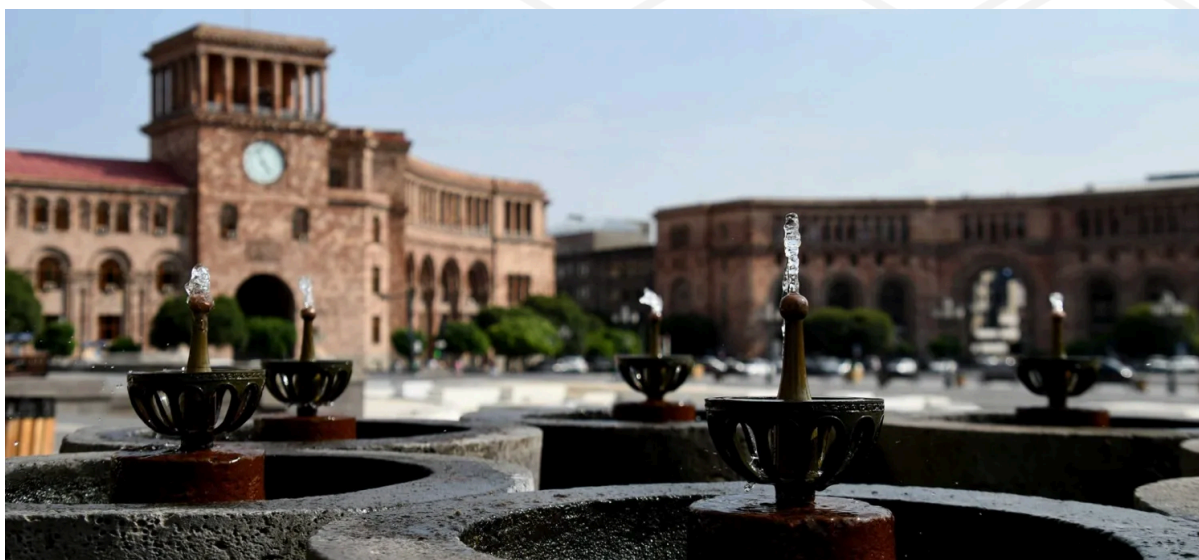




Grand final
International Natural Sciences Tournament 2024
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Extramural round problems

Grand final of the International Natural Sciences Tournament 2024



Pulpulak "Seven Springs" / Photo credit: RARE Water Armenia

1. Perfect Pulpulak

Armenia is known for its pulpulaks (Armenian: պլպլակ), public drinking water fountains that make clean drinking water available for everyone everywhere [1]. Not all countries can brag about such availability and tap water* quality also often remains a point of concern [2]. Apart from drinking, tap water is used for various purposes, requirements for which can be different.

Suggest:

- Range of electrolyte/chemical composition which can make tap water suitable for various purposes (consider drinking, washing clothes, showering, watering plants among others);
- Mechanism of improving quality of poor tap water in a known region of your home country to drinking standards [3];
- Household device(s) that can improve tap water quality making it suitable for each of these purposes (drinking, washing clothes, showering, watering plants).

* By "tap water" we mean any water used for drinking and domestic purposes. (Clarification as of 13.06.2024)

[1] Water in Armenia. *Armenian Geographic* (2023).

[2] Is tap water safe to drink? *National Geographic* (2023).

[3] Drinking-water quality guidelines. *World Health Organization* (2022-2024).



Image generated with Microsoft Designer AI

2. Don't Look Up

Some valuable resources on our planet could be depleted in as little as 30 years, especially the rarest ones necessary to construct computers, smartphones, and other advanced technologies [1-2].

In recent years, significant advancements in technology have made previously unthinkable concepts, such as asteroid mining, a tangible reality. Indeed, asteroids hold vast reserves of these resources and there are several startups spearheading efforts in this field, for example [3].

Propose a comprehensive solution, which includes (but is not limited to):

- Identifying/detecting chemical composition of an asteroid;
- Extracting a valuable resource;
- Transporting the resource back to Earth.

[1] Precious metals in peril: Can asteroid mining save us? *Science in the News* (2016).

[2] Asteroid Mining and Why It Makes "Cents" *KMI* (2023).

[3] AstroForge (2023).

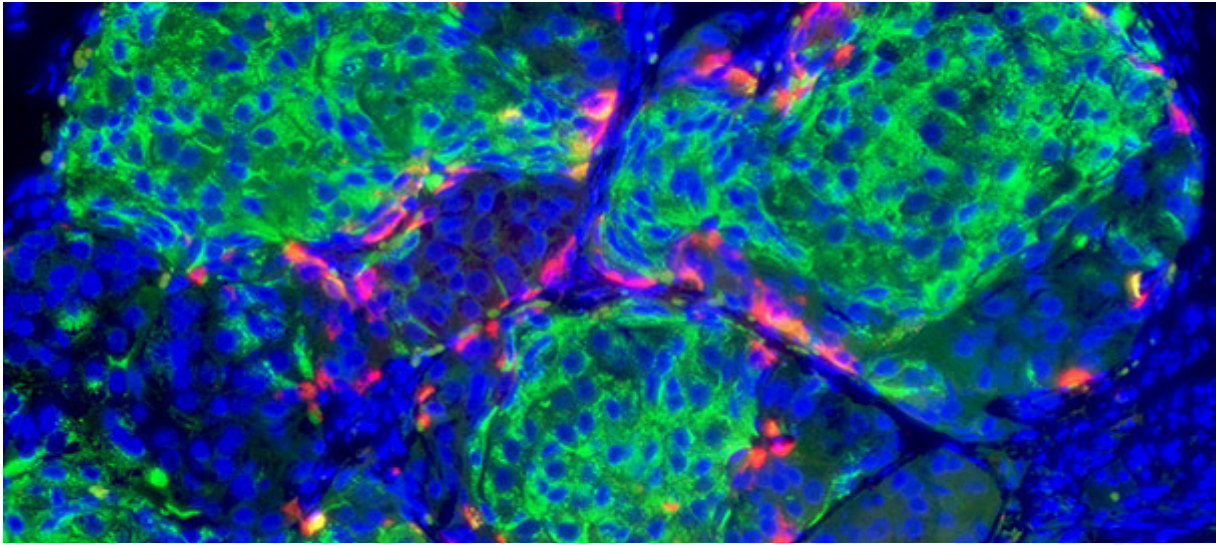


Photo by B. D. Colen / Harvard

3. Diabetes transplants

Type 1 diabetes presents a significant challenge globally, with more than 10 million patients relying on insulin administration for management as there is currently no cure [1]. Insulin therapy is the only available option at the moment, yet all approaches of exogenous injection have severe limitations [2]. One of the most promising avenues for treatment is pancreatic islet transplantation, wherein healthy islets from donors are transplanted into diabetic patients [3-4].

While this approach can restore normal blood sugar levels, one major concern is the immune response of a recipient. To address this issue, current research is focused on developing various methods including encapsulation, cellular modifications, and chemical modifications of the islet surface to prevent immune recognition and attack.

Propose a novel design/method to improve pancreatic islet transplantation for the treatment of type 1 diabetes. Consider factors such as immune compatibility, long-term viability of the transplanted islets, and effectiveness in achieving euglycemia. The design should aim to overcome the limitations of current transplantation methods and offer a more robust and sustainable solution for type 1 diabetes management. Provide a rationale for your proposed approach and consider its feasibility in a clinical setting.

[1] Diabetes. *World Health Organization* (2023).

[2] The epidemiology of type 1 diabetes: Helping to fit the puzzle pieces. *Endocrinol. Diabetes Nutr.* (2015).

[3] Pancreatic Islet Transplantation. *National Institute of Diabetes and Digestive and Kidney Diseases* (2018).

[4] Pancreatic Islet Transplantation in Humans: Recent Progress and Future Directions. *Endocr. Rev.* (2019).



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Important information

The Tournament consists of the Extramural round and Grand final. To participate in the Extramural round the team (3–5 students+coach) should send clear and outstanding solutions of **two out of three** Extramural round problems before **May 12, 2024 (first wave), or June 16, 2024 (second wave)**.

Please, remember the following notes:

- participation in the Extramural round is free of charge;
- participation fees for the Grand final participants of the first and the second waves will be announced later.

Submission of solutions

Each solution of each problem consists of both extended solution (*.doc, *.docx, *.pdf) – 5 pages or less) and presentation (*.ppt, *.pptx *.pdf). The solutions provided in the wrong formats are not accepted. Please, send separate files with presentations and extended solutions for each of the problems. **Pay attention that there have to be no names, logos, or any other identification marks of your team/university in the presentations or extended solutions.** All the solutions have to be sent before the deadline via the account on the [website](#).

Recommendations

Extended solution

- Your team have to provide the neat document in *.doc, *.docx, *.pdf formats (5 pages or less).
- All the parts of the extended solution should be linked, the course of the solution should be convincing and understandable, the information should be comprehensible and sufficient to understand the essence of the problem and the proposed solution.
- While preparing the extended solution, it is recommended to keep in mind the following questions:
 - What is the essence of the problem and what is required to be solved?
 - What is known about this problem in literature sources? Have any solutions been already proposed for the problem? What are the pros and cons of the known solution?
 - What is the essence of the solution you propose? How to implement it in practice? What are its pros and cons? Are there alternative solutions?
 - What conclusions can be drawn from the work you have done? What solution to the problem do you propose as the best and why?



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- If it is necessary, provide an economic evaluation of proposed ideas, their profitability.
- When using information from literature, one should put the source referred to at the numbered list of references at the end of the extended solution. Do not forget to refer to these sources with figures, for example [1] or ¹.
- If your team has conducted any experiment during the solving of the problem, it is highly recommended to include any information about it in the extended solution even if the result does not satisfy your team.

Presentation

- Your team should provide the neat document in *.ppt, *.pptx, *.pdf formats (the number of slides is not limited but, please make it reasonable).
- Please, keep in mind that your presentation must correlate with your extended solution.
- The presentation should not be overloaded with text. It should contain only illustrative material that supports the extended solution and makes the solution clearer and easier to understand. Text in the presentation is recommended to be used for titles, labels, formulas, brief thesis sentences, as well as conclusions and the list of references.
- All slides of the presentation, except the title slide, should be numbered.
- All the pictures, graphs, tables, or any other graphical content should be clearly labelled. If this material is not original, then one should refer to the corresponding source of literature with figures.
- When using information from literature, it is recommended that the source is referred to at the bottom of the slide (by giving its bibliographical reference, including the title of the work). If it is inconvenient to put the full reference title on the slide, one must make a separate slide with a numbered list of references and refer to these sources with figures, for example [1] or ¹.
- If your team has conducted any experiment during the solving of the problem, it is highly recommended to include any information (especially pictures, numbers, tables, etc.) about it in the presentation even if the result does not satisfy your team.

If you have any questions regarding the presented information, please do not hesitate to contact Teams' coordinators Anastasiia and Dmitrii via e-mail: tournament@scitourn.com.