THE ROYAL SOCIETY

How can we get the best plant growth using hydroponics?

1. Project overview

Duration of project
2 terms minimum to allow for plant growth time. Easily repeatable year-on-year
Can be considered as part of the Tomorrow's Climate scientists programme

Through this project students will be able to investigate the benefits and drawbacks of growing plants in a hydroponics system. They will gain a greater understanding of photosynthesis and how plants process nutrients to grow. Working with their STEM partner, the students will be able to explore the different conditions that can enable plants to thrive in a soilless growing environment. They will also be able to trial different forms of pest control to help their crops flourish, implementing and evaluating the most popular ideas and communicating their findings with the wider school community. Linking strongly to the curriculum, this project will enable teachers to inspire the next generation of botanists looking to achieve long term food security. Details of the investigative work required to support this project can be found in section 4.

2. Student involvement

This project is aimed at secondary students aged between 11 – 16, however, it could be adapted to suit other age groups and abilities. This project can be adapted to suit large groups, from clubs to whole year groups or larger, and we encourage projects to be as inclusive as possible. The project can be used to engage a wide variety of students in the school. For example:

1) older students mentoring younger years to engage with the observation and monitoring sections of the investigation
2) students with an interest in art and design helping to communicate the findings of the project to the wider school community via medium such as video, posters etc.
3) students with an interest in design helping to design and set up the hydroponics systems.

3. STEM partner involvement

Funding will only be offered to schools that can demonstrate a strong partnership. The partnership can either be with one individual STEM partner or a team of STEM partners. If there is a team of STEM partners, one must be identified as the lead STEM partner for the application process and must have sustained and meaningful engagement (in-person or online) with the students and teacher throughout the duration of the project. Other STEM partners in the team can support the project, if needed, to provide specialist knowledge or to help spread the time commitment and ensure the students have regular STEM partner engagement. For a two-term project such as described here, we would expect a ***minimum of 7 in-person visits over the course of the project***, undertaken by any of the STEM partners involved. The STEM partner(s) will provide the students with relevant guidance and knowledge to help them with their investigations, as well as an insight into potential careers.

The main role of the STEM partner(s) is to support the planning, design and implementation of the investigation that the students will carry out. Examples of how the STEM partner(s) could support the implementation of the investigations include (but are not limited to):
supporting the practical parts of the project such as:

- supporting students to form their own hypotheses
- supporting students to set up their investigations following the scientific method

- helping provide secondary research sources and support the understanding of technical information
- helping with data collection and identification
- helping the development and implementation of student plans to improve plant growth
- helping with any location, building or design elements

Other activities that the STEM partner could get involved with are:

- arranging a visit to their place of work
- providing an introductory talk to the project group, or whole school, regarding their career and the relevance of this to the project being undertaken; and
- supporting the students end of project presentations.

Examples of STEM partners that could support this project are university or industry-based researchers, with a degree or equivalent background in a subject such as chemistry, material science/engineering, electrical engineering, energy storage systems, ecology, environmental biology, sustainability or management, plant sciences, botany and biodiversity. Professionals who are working in farming, food production or crop development and maintenance.

For more information about the STEM partner eligibility requirements and guidance on how to find a STEM partner, please read the What is the partnership page on our website.

4. Investigation options

The following investigations described in the plan below will underpin this project and help the students answer the project title question. Please note some of the investigations may need to take place in parallel rather than sequentially throughout the year. The individual investigations suggested may need to be adapted or altered, dependant on the school facilities and space available. Teachers can also add in additional investigations and other project elements as required.

Project plan	Equipment suggestions
Initial set up and research: Set up the hydroponics kit, ensuring a stable environment around the kit for fair testing. Carry out secondary research to learn what types of plants suit a hydroponics environment and why. Research key variables that may affect plant growth and why. Common variables include: hours of light exposure, light wavelength, light intensity, temperature, humidity, water PH, water nutrient levels.	Hydroponics kit/bed Temperature monitor Polly tunnel (optional if located outside) Access to the internet
Main Investigation: 1. Investigate the best plant species to grow in your hydroponics system. Keep the growing conditions the same and grow a sample of the plants to see which grow best. Consider how to measure what 'best' looks like (speed, height, number of leaves/stems, colour?) making predictions at the start of the investigation and see if the results confirm of disprove this.	Plant plugs or seeds of chosen plant varieties.

The collect data can also be used as a base line for further investigations.	
2. Investigate what combinations of light wavelength are optimum for the growth for a single plant species. Choose a single fast growing plant (as determined in part 1) and explore the effect of single wavelengths, using this to inform options for combinations of wavelengths to further improve growth (i.e. different colours together or different % of coloured light).	Multi wavelength LEDs or coloured light filters/films
3. Investigate the optimal light intensity for the growth for a single plant species.	Photometer
4. Investigate mineral combinations and concentrations that are optimal for the growth for a single plant species. Use a selection of nutrient supplements researching in advance the plants nutrient needs. Note: Ph level and levels of nutrients in the water over time may vary and have an effect on growth.	Different Nutrient supplements. PH monitor (water safe) Electrical current meter (water safe)
5. Identify any pests that have been attracted to the plants (differentiating between harmless or important pollinating insects) and propose low environmental impact interventions that can be tested to reduce the pests identified.	Funds for pest control solutions to be tested.
Wider communication: Communicate the results to the wider school community; methods could include information leaflets/posters, school assemblies, getting other years practically involved in the project, or a short film.	Please note: additional film grants towards a camera / software / microphones etc. are available to grant holders.

A suggestion of essential equipment and supplies needed to undertake each of the parts of the project has been listed to assist you when putting together your budget. Please also consider any relevant additional costs permitted within the scheme, such as teacher cover, essential teacher CPD and/or travel costs for project related visits. For more guidance please read the eligibility and judging criteria page on our website.

5. Benefits and skills

Involvement in a long term investigative project should enable students to have an in-depth experience of working scientifically as well as developing their general team working and communication skills.

Through this project the students will specifically learn about photosynthesis and plants' use of nutrients to grow in a real world context, gaining detailed knowledge about using hydroponics to grow plants as well as a broader understanding of the conditions needed for good plant growth and the issues of food security. They will learn skills in research, observation and monitoring, identification, data capture, data

analysis and problem solving. Dependant on the exact investigations and activities you propose to undertake, there may be additional benefits and skills you can identify in your application.

6. Legacy activities

It is important that Partnership Grant projects are sustainable, providing long-term benefits to your students and wider school community in terms of the teaching and learning of STEM subjects.
Your legacy activities could include (but are not limited to):

- repeating the project with successive year groups
- re-using the equipment to gather evidence on the long-term impact of the student's chosen growth conditions, possibly even producing crops for use in the school canteen.
- testing other growth conditions, possibly looking at aquaponics and the use of fish as sustainable providers of nutrients.
- expanding the project to include other schools in the area, loaning out the hydroponics set up or providing training sessions on set up, to collate more evidence to compare with your own.

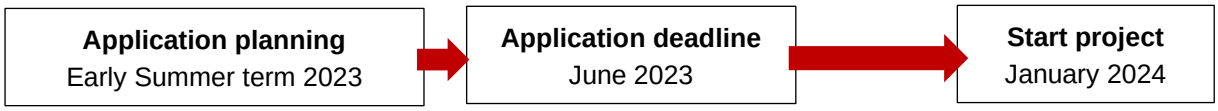
7. Next steps

1 - Securing your STEM partner

Using the information about STEM partners above, search for universities and businesses within reasonable travelling distance to you that might have suitable contacts to approach. A good route to finding these contacts is often your own school's Governors and student's parents, another is the national STEM Ambassador scheme. Once you have a few contacts in mind, write an email/letter inviting them to be involved in the project, providing clear and concise information about areas you need support with, the time commitment you are expecting, and the duration of the project. If you need further advice as to how to find a STEM partner, please contact the Schools Engagement team directly via education@royalsociety.org .

2 - How to start an application

This project is ideally started in the spring term to allow the project to run at least 2 full terms during favourable growing weather. To get the funding secured and paid in time, you will need to submit the full grant application for the June deadline in the academic year before. An example timeline is given below, and more information about The application process and timelines can be found on our website.



You can access the application form via the Royal Society's grant management system called Flexi Grant: https://grants.royalsociety.org/. When you first create your log-in and access Flexi Grant several grants will be visible on the screen. Please make sure you choose the ***Partnership Grants stage 1*** form to start.

3 - Where to get more information

You can find full information about the Partnership Grants scheme, including eligibility and judging criteria, application guidance and exemplar forms via our website: www.royalsociety.org/partnership

If you have specific questions about your project idea, STEM partner or application, please either attend one of our online training sessions or please contact the Schools Engagement team directly via education@royalsociety.org .