Argonne ACT-SO High School Research Program (ARP)

Mentor Expectations and Guidelines

2020-2021

Thank you for volunteering as mentor for the Argonne ACT-SO High School Research Program!

The following is meant to be guide to the program and expectations of both students and mentors in the Argonne ACT-SO High School Research Program (ARP). Please refer to this document and the ACT-SO Science Guidelines regularly during the program. If you have additional questions please contact the program ARP Co-Chairs.

Co-Chairs actso@anl.gov

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About the Program

The Argonne ACT-SO High School Research Program (ARP) is an in-depth research, mentoring and enrichment program highlighting the talents of African-American high school students. Argonne partners with DuPage County ACT-SO, a youth initiative of NAACP, to provide competitive, project-based exploration of STEM fields. Students also increase their technical knowledge and are exposed to education/career paths through mentorship and guest speakers.

Argonne National Laboratory mentors students in the following ACT-SO Categories: Biology/Microbiology, Chemistry/Biochemistry, Computer Science, Earth/Space Sciences, Engineering, Mathematics, and Physics.

ACT-SO has been a program of the DuPage County NAACP chapter for the past 36 years. Now in its third year, the ARP provides mentors and facilities to help students prepare their research for competition. The Argonne volunteer mentors work with the students over a period of seven months.

The goal of the program is to guide students into STEM disciplines that often connect poorly to communities of color. Without this pipeline—which includes mentors that challenge students to excel and provides them with access to industry-standard technologies and supportive communities—students can find themselves without guidance to pursue STEM careers.

Students develop independent research projects that are designed to test a hypothesis. The students should be drivers of the project and their results and mentors are there to provide support and additional ideas. In addition, mentors need to serve as the filter for feasibility, safety, and experimental design.

Each mentor will be assigned a students. We will make every effort to match students and mentor interests. Some students enter the program with defined projects or interests, and we will

pair these students the best we can with available mentors. Some of our students are freshman and sophomore students who have not had exposure to a wide variety of science classes. These students are interested in science, but may not have a defined project area and are willing to work on a project related to your interests or research area.

Program Structure

The program meets on Saturdays once a month at Argonne from 8:30 am – 1 pm.

- November 7
- December 5
- January 9
- February 6
- March 6
- April 3

These sessions are both enrichment and mentoring sessions for ARP students. The first part of each session (8:30-10:30 am) is dedicated to whole group enrichment sessions with all ARP students. These consist of speakers on science careers, laboratory safety, workshops on scientific paper writing, poster preparation, and presentation skills. The second portion of each session (10:30 am – 12:30 pm) is dedicated to breakout time with individual mentors and students. Students and mentors can work on experimental, computational, or other work at this time. Lunch is provided to conclude the session (12:30-1 pm).

Mentors are expected to attend at least 4 of the Saturday sessions at Argonne and make arrangements to meet with their mentee(s) individually if they cannot attend.

Mentors will also need to meet with their students regularly outside of the scheduled sessions at Argonne. These meetings may take place in person at Argonne or another other location decided with students and their parents, or via phone, Skype, Google Hangout, etc. Mentors and students should communicate ***at least weekly*** by phone, email, or video chat. Some students and mentors may prefer weekly in person or Skype/Google Hangout meetings.

All communication (email, phone, text, Skype, Google Hangout, etc.) between mentors and students should include the student's parents. In person meetings, whether at Argonne or off-site, should include a parent or an additional ACT-SO mentor/volunteer.

The largest time commitment for both students and mentors is January – mid-March. Most data collection and analysis occurs in January and February. Student papers and posters are due in early to mid-March. Please anticipate spending at least 2 hours / week in addition to the Saturday sessions with your student during this time frame.

Competition Categories and Research Projects

ACT-SO Science students compete in the following categories:

- Biology/Microbiology
- Chemistry/Biochemistry
- Computer Science
- Earth and Space Sciences
- Engineering
- Mathematics
- Medicine and Health
- Physics
- Architecture

Students need to develop a research project in coordination with the ACT-SO Science Guidelines. These projects need to have a testable hypothesis and ***be an experiment, not a demonstration.***

The results of the student research projects are presented in a 5 page paper due at the beginning of March. This paper includes:

- Purpose
- Hypothesis
- Materials
- Procedure
- Data
- Results and Analysis
- Conclusions

This paper should be the culmination of their 6+ months of work, and should be what the students are working toward from the beginning. Students typically complete their purpose and hypothesis first, then perform their experiments and write the materials and procedure, and finally analyze their data to write the results and analysis and conclusion sections. Most students will have much more data and analysis than will fit in five pages and must analyze their data to describe the most important results in the paper. Additional data and analysis can be included as supporting information.

In addition to the 5 page paper, students will prepare a presentation poster as a single PowerPoint slide (max. size 3 ft. x 4 ft.), for presenting their data the Local Competition. The poster is due

for printing by ARP one week before the Local Competition. The poster should include the same sections as the paper and key results / figures / analysis.

Experimental Work

Students participating in ARP have the opportunity to perform experimental work at Argonne and use facilities in the Learning Labs in Educational Programs. Many common instruments and laboratory supplies are already available from Educational Programs or donated equipment. Mentors can also bring small portable instruments from their own labs use in the student space. If you need specific equipment or instrumentation, please contact an Argonne Co-Chair.

Mentors who want to perform laboratory work with their students at Argonne will need to fill out a safety analysis form (example in **Appendix**) detailing the experimental procedure and safety hazards. Safety Analysis Forms must be approved by the ESH coordinator, John Domyancich (jdomyancich@anl.gov) before experiments begin. The student laboratory is available for student use from 10 am - 3 pm on the following dates:

- TBD (pending Covid)

Please contact John at least 1 week in advance to confirm your plans to use the open lab space.

On Saturday meeting dates at Argonne, the lab will also be available for student work from 10:30 am -1:30 pm. If you need additional time to work in the lab outside of these scheduled sessions, please contact John Domyancich to schedule a mutually agreeable time to use the laboratory with your student.

Students should have watched the appropriate safety modules in the Dow Lab Safety Academy (http://safety.dow.com/en) prior to laboratory work. Anyone in the laboratory (students, parents, mentors, additional volunteers, etc.) must wear long pants, closed toed shoes, and safety glasses at all times. We will provide safety glasses and additional PPE as needed. A member of the educational programs staff is required to be in the building and aware of all ongoing experiments when students are working in the lab.

Computational Work

Students also have access to computational resources as needed for the ARP. We have a license for LoggerPro, a commonly used data collection and analysis software program at the high school and college level, which can be distributed to anyone connected to our program. Please contact Jarrad Hampton-Marcell (jhampton-marcell@anl.gov) for the LoggerPro license information. If you have additional specific software or other computer needs, please contact Jarrad Hampton-Marcell.

Projects Involving Human Subjects

We have developed an informed consent form for any student project that involves human subjects (see **Appendix**). Students should work with their mentors to specify the possible hazards and determine how confidentiality will be maintained. Please contact Jarrad Hampton-Marcell (jhampton-marcell@anl.gov) to receive an electronic copy of this form.

Resources

Internet:

Students and non-Argonne mentors can connect to the Argonne Guest Network while on site. You may need to restart your computer after registering with the network to pick up the IP address. Students and mentors can access the Argonne Library from the Guest Network.

Data Analysis:

- Google Docs/Drive – editable, collaborative documents available on the cloud. Works with mobile and tablet devices.
- LoggerPro3 Software – Used for data analysis in many high school and college settings. Connects to Vernier data collection instruments which may be used in student experiments. ARP license available to all students and mentors (contact Jarrad Hampton-Marcell)

Paper Writing:

- Google Docs – collaborative, editable documents that are available on the cloud
- Authorea – Authorea is the collaborative editor for research. Write and manage your documents in one place, for free. (https://www.authorea.com/)
- Citation Builder – Works with multiple citation formats (https://www.lib.ncsu.edu/citationbuilder/)

Poster Preparation:

- Microsoft PowerPoint – templates and outlines for student posters are provided in this format

Mentoring High School Students

- See attached tip sheets for best techniques for mentoring young people

Dates and Deadlines and Schedule for Completing Research:

November– Initial meeting, mentor assignment, project design

December – Project design and development of hypothesis, background research

January – Background research, writing purpose section of paper, begin experiments

February 15 – Progress Report #1 Due: *Title, Competition Category, Background and Hypothesis sections of written report*

February – Experiments, data analysis, writing materials and procedure section of paper

March 15 – Progress Report #2 Due: *Experimental / Computational Procedure of written report including a timeline for completion of the research project*

March February – Wrap up experiments, continue data analysis, and start writing results and analysis and conclusion sections of paper

March 15 – Progress Report #3 Due: *Full draft of written paper in current state with completed experiments/calculations, and written plan to finish the project before the March deadlines*

Early April – Work on preparation of competition poster, revisions of poster with mentor

April 3rd – Final Draft of Paper due to DuPage County ACT-SO for Local Competition (printed, ACT-SO deadline for students)

April TBD – Final local competition poster due to ARP for printing

April TBD – Local competition at College of DuPage

April TBD – ACT-SO Awards Banquet

TBD – Local Gold Medalists make revisions to papers for National Competition

TBD – Local Gold Medalists make revisions to posters for National Competition and practice for competition (Time and Date TBD)

July – ACT-SO National Competition, July 20-23, 2017, Baltimore, MD

Appendix

Appendix # 1: Student Research Paper Format

Appendix # 2: Example Student Research Poster – Poster templates will be provided to students in February, but posters may be free form (not template), with a maximum size of 3ft x 4ft. Posters should be 1 slide/page in PowerPoint or PDF formats.

Appendix #3: Example Safety Analysis Form for ESH approval

Appendix #4: ACT-SO Student Projects Human Informed Consent Form

Appendix #1

Student Research Paper Format

- Main paper maximum of 5 pages, double spaced
- No page limit to Bibliography or Supporting Documents

Title Page – Title of Project, Student Name, DuPage County ACT-SO Unit 3012

Purpose/Background – 1-2 pages, outlining why project is important and information needed to understand project; should be properly cited throughout

Hypothesis – Should be clearly stated with expectations of outcome

Materials – Can be list or table

Procedure – Can write as a paragraph or a numbered list

Data – Key results should be included in the main paper; any additional data that does not fit in 5 page paper can be included as Supporting Documents (no page limit)

Results and Analysis – Explain data (~1 page) and methods used to analyze data

Conclusions – Short summary of key findings (~1/2 page)

Bibliography – Not counted in page limit; should include all references used in paper; pick a consistent citation style for your research area.

Supporting Documents Title Page (if necessary) – Title of Project, Student Name, DuPage County ACT-SO Unit 3012

Supporting Documents (if necessary) – Any additional data, analysis, figures, or other information that supports the paper but cannot fit in 5 page limit

Science Verification Form – 1 page form for mentor to fill out to discuss independence of student work (used by ACT-SO judges)

Appendix #2

Example Student Research Poster

(This project won a Gold Medal at ACT-SO Nationals 2015)

A Study on the Media Optimization of Cellulose Based Fermentation Process Utilizing *Cellulomonas sp.* and *Zymomonas mobilis*

Tavis Reed, DuPage County ACT-SO, Chemistry-Biochemistry

Abstract

Cellulosic ethanol is the future of the ethanol industry. Using cellulosic material is much cheaper than using corn to make ethanol. The only thing currently preventing it from dominating the ethanol industry is a lack of known profitable production processes. This experiment optimized production of a bacterial cellulosic ethanol process that was developed in 2014. This experiment demonstrated that the only materials necessary for the process to work were yeast extract, DI water, cellulosic material, and the bacteria. In addition, this process produced several valuable byproducts (acetic acid, lactic acid and glycerol).

Introduction

- It is relatively expensive to make ethanol from corn, costing about $1.95 per gallon to make, with $1.43 being the cost of corn.
- This experiment examines the bacterial process of cellulosic ethanol formation under different media conditions.
- The control media was based on a previous experiment that proved the bacteria could be grown together in this media.
- *Cellulomonas sp.* breaks down cellulose into glucose using cellulase.
- *Zymomonas mobilis*, is capable of fermenting glucose to produce ethanol.

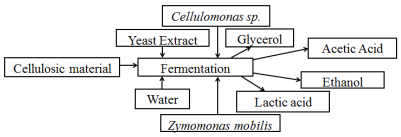


Figure 1. Flow chart for fermentation process.

Hypothesis

If *C. sp.* and *Z. mobilis* are grown on only yeast extract, DI water, and a reduced source of cellulose (cotton), then they will produce as much ethanol as if they were grown on peptone, tryptone, K_2HPO_4, yeast extract, DI water, and cotton, as is currently performed in industry.

Procedure

1. Flasks Preparation

1.1 – 1.6 Add base and feedstock to flasks

0.25 g of Tryptone
0.25 g of Peptone
0.25 g of K_2HPO_4
0.25 g of Yeast Extract
0.25 g of Cotton (cellulose source)
50ml of DI water.

Control minus: **K_2HPO_4** — Flask 1

Control minus: **Tryptone and Peptone** — Flask 2

Control — Control with **0.13 g of Cotton** — Flask 3 — Control with **0.06 g of Cotton** — Flask 4 — Control with **0.03 g of Cotton** — Flask 5

1.7 Place flasks in autoclave for 2 hours to sanitize.

1.8 Place 100ul of *Z. mobilis* and 100ul of *C. sp.* into cooled flasks.

1.9 Place flasks in shaking incubator at 30°C. Allowed to grow and ferment for 48 hours.*

*Control flask, flasks 1 and 2, kept in incubator 2 additional weeks until flasks 3-5 were grown.

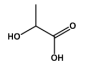
2. Sample Taking and Analyzing

2.1 Measure and record pH

2.2 Measure and record ethanol concentration using FTIR (Fourier Transform Infrared) spectroscopy for an OH stretch at 1040 cm^{-1}.

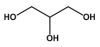
2.3 Measure and record concentration of acetic acid at 1750 cm^{-1}, lactic acid at 1150 cm^{-1} and glycerol at 3250 cm^{-1} by FTIR.

Products



Lactic Acid

Ethanol



Glycerol

Acetic Acid

Results

- *C. sp.* and *Z. mobilis were* able to produce ethanol when grown on just yeast extract, no K_2HPO_4, and only 0.25% cellulose.
- All major byproducts were identified and quantified.
- Flask 1 and 2 contained nearly twice the amount of ethanol as Flasks 3, 4, and 5 due to Flask 1 and 2 fermenting for a longer period of time (2 weeks).

Flask #	Glucose in flask	Glucose Consumed by *Z. mobilis* (Efficiency)	Ethanol %	Acetic acid %	Lactic acid %	Glycerol %
Control	1.39 mmol	2.90%	3.59%	2.68%	4.12%	1.86%
1	1.39 mmol	17.86%	22.13%	1.81%	1.56%	4.03%
2	1.39 mmol	19.45%	24.10%	3.03%	5.51%	1.10%
3	0.693 mmol	23.08%	14.26%	3.71%	1.39%	4.03%
4	0.347 mmol	45.80%	14.17%	1.51%	1.80%	5.50%
5	0.173 mmol	88.76%	13.69%	3.81%	1.39%	4.75%

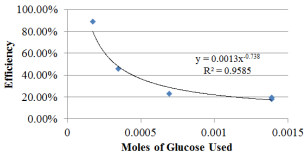


Figure 2. Efficiency of cellulosic ethanol production process per mole of glucose used.

Conclusions

- It is better for ethanol production to grow *C. sp.* and *Z. mobilis* on only yeast extract, DI water and a small amount of cellulosic material.
- It was determined that it would cost $0.30 to make a gallon of ethanol using this process, with cellulosic material making up $0.01 of this cost.
- Even though efficiency increases as the amount of glucose available to *Z. mobilis* increases, this does not necessarily mean that Flask 5 contained the optimal amount of cellulose.

Future Work

- Determine the interactions happening between the bacteria that permit them to survive under conditions where they typically die or go dormant.
- Produce a distillable quantity of solution to confirm the chemical concentrations by an additional analytical method such as gas chromatography.

Acknowledgments

Argonne National Laboratory
Dr. Sarah Soltau & Dr. Deon Ettinger

Illinois Mathematics and Science Academy
Dr. Don Dosch and Dr. John Thurmond

Appendix #3

SAFETY ANALYSIS FORM

Communications, Education and Public Affairs Division

CEPA-ED Department

This form is to be completed for all educational, outreach and research-focused activities that students will be conducting during their time at the Learning Center. All programs will need to have this form completed and on file with the Education office.

Name of Program (ACT-SO, IGED, SCSW, etc.)	
Date of Submission	
Date(s) of Activities	

Section 1. Activity Description (Provide a step-by-step experimental procedure for the work being done. Attach a separate sheet, if desired.)

Principal Staff Member	
Student/Age/School	
Location(s) of Activities	

(OVER)

Section 2. Safety and Health Issues and Precautions

Safety Issue	Precautions

Please check the following:

☐ I ensure that, at no time, the student will be left alone in the lab.

☐ I ensure that, at no time, I will (the facilitator/mentor) be alone with a participant.

☐ It is my belief that I have identified all of the hazards relating to this activity and that by taking the precautions listed above the participant(s) and staff will be safe throughout.

_____

Signature, Principal Staff Member Date

APPROVAL SIGNATURE:

ES&H Coordinator, CEPA _____ Date_____

Appendix #4

ACT-SO Student Projects
Human Informed Consent

Directions for Student Researcher(s): An informed consent/assent/permission form should be developed in consultation with the Adult Sponsor or Scientific Mentor. This form is used to provide information to the research participant and to document written informed consent.

Title of the Project: _____

Student Researcher(s):_____

I am asking you for your voluntary participation in my ACT-SO Science project. Please read the following information about the project. If you would like to participate, please sign the appropriate box below.

Purpose of the project:

If you participate you will be asked to:

Time required for participation:

Potential Risks of the Study:

Benefits:

How confidentiality will be maintained:

If you have any questions about this study, feel free to contact:

Adult Sponsor:_____

Phone/email:_____

Voluntary Participation:
Participation in this study is completely voluntary. If you decide not to participate there will not be any negative consequences. Please be aware that if you have decided to participate, you may stop participating at any time and you may decide not to answer any specific question or perform any specific task.

By signing this form I am attesting that I have read and understand the information above and I freely give my consent/assent to participate.

Printed Name of Research Participant: _____

Signature of Research Participant: _____

Date: _____

If research participant is under 18, a parent's permission is required:

Printed Name of Parent: _____

Signature of Parent: _____

Date: _____