MONTANA REGION II

SCIENCE AND ENGINEERING FAIR

Montana Region II Science & Engineering Fair

2020

Handbook

GREAT FALLS COLLEGE
MONTANA STATE UNIVERSITY

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Montana Region II Science & Engineering Fair Registration Deadline

Midnight, Wednesday, March 4, 2020

Go to http://www.gfcmsu.edu/sciencefair/studentreg.html to register.
Registration officially opens on Friday, January 31, 2020.

How to Enter the Region II Science & Engineering Fair

1. Pick a science or engineering topic that YOU are interested in.
2. Read this booklet carefully.
3. Choose an adult sponsor. It may be your teacher, your parent or another interested adult.
4. Develop your *Research Project Proposal* and then complete the *Project Proposal Checklist* to see if you need to complete any other forms. If you do, complete those as well.
5. Complete the forms and email them to the Science Fair Coordinator, Dr. Leanne Frost, at leanne.frost@gfcmsu.edu or mail them to Region II Science Fair, 2100 16th Avenue South, Great Falls, MT 59405.
6. Registration will be available online at http://www.gfcmsu.edu/sciencefair/studentreg.html on January 31, 2020.
7. Students who select projects that involve human subjects, non-human vertebrates, recombinant DNA, pathogens, controlled substances or human/animal tissue must receive written Science Fair approval - read the handbook for exceptions – will have their Project Proposals reviewed by the Science Review Committee for safety and will receive notice if they are approved or if they should be modified.
8. All rules, guidelines, state and federal laws governing safety in research and the ethical treatment of animals must be followed.

If you have any questions, please contact Leanne Frost at 406-771-4372 or leanne.frost@gfcmsu.edu.
Visit our website for current information on the Region II Science Fair at http://www.gfcmsu.edu/sciencefair/.

The top 10% of projects in grades 6, 7, and 8 will be eligible for further competition in the ISEF Broadcom MASTERS (Math, Applied Science, Technology and Engineering for Rising Stars) event. More information may be found at https://student.societyforscience.org/broadcom-masters-faq.

The top two high school grand award project winners go on to compete at Intel ISEF. The 2020 event takes place May 10-15, 2020, in Anaheim, California. More information may be found at https://www.societyforscience.org/ISEF2020.

Please Note:
It is to be expected that the level of sophistication of the science project will increase with the student's grade level. Most elementary projects will be exempt from needing prior approval and all of the extra paperwork (the need to complete the supplemental forms).

If you are having a problem determining if your project is exempt, please call Dr. Leanne Frost at 406-771-4372.

The reason for all of the precautions is to ensure that the students and those around them remain safe while they learn.

Before Beginning Your Project

Visit the ISEF Rules wizard (https://ruleswizard.societyforscience.org/) to determine which, if any, forms you will need to provide with your project.

The Scientific Method:

- The scientific method is a way to ask and answer scientific questions by making observations and doing experiments.
- The steps of the scientific method are to:
    - Ask a Question
    - Do Background Research
    - Construct a Hypothesis
    - Test Your Hypothesis by Doing an Experiment
    - Analyze Your Data and Draw a Conclusion
    - Communicate Your Results
- It is important for your experiment to be a fair test. A "fair test" occurs when you change only one factor (variable) and keep all other conditions the same.
- While scientists study how nature works, engineers create new things, such as products, websites, environments, and experiences.
    - If your project involves creating or inventing something new, your project might better fit the steps of the Engineering Design Process.

The Engineering Design Process

- The engineering design process is the set of steps that a designer takes to go from first, identifying a problem or need, to creating and developing a solution that solves the problem or meets the need.
- The steps of the engineering design process are to:
    - Define the Problem
    - Do Background Research
    - Specify Requirements
    - Create Alternative Solutions
    - Choose the Best Solution
    - Do Development Work
    - Build a Prototype
    - Test and Redesign
- During the engineering design process, designers frequently jump back and forth between steps. Going back to earlier steps is common. This way of working is called “iteration”, and it is likely that your process will do the same!
- While engineers create new things, such as products, websites, environments, and experiences, scientists study how nature works.
    - If your project involves making observations and doing experiments, your project might better fit the Steps of the Scientific Method.

Comparing the Engineering Design Process and the Scientific Method

While scientists study how nature works, engineers create new things, such as products, websites, environments, and experiences. Because engineers and scientists have different objectives, they follow different processes in their work. Scientists perform experiments using the scientific method; whereas, engineers follow the creativity-based engineering design process.

Both processes can be broken down into a series of steps, as seen in the table below.

The Scientific Method	The Engineering Design Process
State your question	Define the problem
Do background research	Do background research
Formulate your hypothesis, identify variables	Specify requirements
Design experiment, establish procedure	Create alternative solutions, choose the best one and develop it
Test your hypothesis by doing an experiment	Build a prototype
Analyze your results and draw conclusions	Test and redesign as necessary
Communicate results	Communicate results

Why are there two processes?

Both scientists and engineers contribute to the world of human knowledge, but in different ways. Scientists use the scientific method to make testable explanations and predictions about the world. A scientist asks a question and develops an experiment, or set of experiments, to answer that question. Engineers use the engineering design process to create solutions to problems. An engineer identifies a specific need: Who need(s) what because why? And then, he or she creates a solution that meets the need.

Which process should I follow for my project?

In real life, the distinction between science and engineering is not always clear. Scientists often do some engineering work, and engineers frequently apply scientific principles, including the scientific method.
Much of what we often call "computer science" is actually engineering—programmers creating new products. Your project may fall in the gray area between science and engineering, and that's OK. Many projects, even if related to engineering, can and should use the scientific method.

However, if the objective of your project is to invent a new product, computer program, experience, or environment, then it makes sense to follow the engineering design process.

Important Note: Science Expo accepts engineering projects completed using the engineering design process. But if in doubt, use the Scientific Method.

** Material above cited from https://www.sciencebuddies.org/science-fair-projects/science-fair.*

Tips for a Successful Science Fair Project

1. **Observe** the world around you.
    1. Don't confuse observation with interpretation.
    2. What interests you? What do you find fascinating?
2. **Focus** your topic.
    - Don't make your topic too broad.
    - Do enough background research to narrow your topic successfully.
    - Does your topic still give you room for exploration?
3. **Hypothesis** is an educated guess about your observations of the world around you.
    - Is your hypothesis testable?
    - Will you have the resources to test hypothesis or are resources available?
    - Your hypothesis should be simple and precise.
    - Don't form conclusions until after you have collected all the data.
4. **Follow Science Fair Rules**.
    - For rules and regulations at the Science Expo, see previous sections: "Rules and other Useful Information" and "Display and Safety Regulations".
5. **Add your own touch** to a science experiment
    - If you are doing an experiment that is "old hat," can you push the hypothesis further by adding a different variable?
    - Repeating a project off the internet is NOT science! It's cooking!
6. Make a **plan** with timetables.
    - Are you going to have enough time to complete the experiment?
    - Don't rush yourself this leads to sloppy workmanship and it isn't an award-winning science fair project.
7. Have a **well-defined purpose**.
    - A defined purpose will help you narrow the scope of your experiment.
    - Use scientific references to base your experiment on.
8. Have a **control group** and **limit variables**.
    - For example, if you were doing an experiment to see what the effect of the soil conditions were on a certain plant, you need to keep the light and water conditions the same.
    - Limit the number of variables that you test.
9. **Use scientific measures**.
    - Scientists record measurements using the metric system and scientific units like the gram for weight, meters for length, and liters for volume.
10. Keep a scientific **logbook**.
    - You need to record your procedure, observations, and data diligently into a logbook. If you don't know what a logbook looks like visit www.sciencebuddies.org to help you organize your log book. Just search Logbook.
11. Ask questions and be resourceful.
    - **Get help** from teachers, parents, mentors, or websites. https://www.educationworld.com/awards/past/r1298-09.shtml has a lot of resources.
12. **Put it all together**.
    - Put just enough information on the poster to clearly state your case.
    - Check for spelling and grammar.

You can also check out http://www.accessexcellence.org/LC/TL/scifair/sfscimethod.html.

Rules and Other Useful Information

1. All research projects must have an adult sponsor (a parent, a teacher or a mentor).

2. All participants must be enrolled in Grade K through 12 either in a public, private, parochial, or home school located within the officially sanctioned regions for the Region II Science & Engineering Fair: Cascade, Lewis & Clark (Augusta), Teton, Pondera, Toole, Glacier, Liberty, and Judith Basin Counties.

3. The acceptance of the application for competition does not imply approval of any proposed exhibit. All exhibits must first be vetted by the Display and Safety Committee on the day of competition to ensure it conforms to all safety regulations.

4. A student may enter only one research project and it must be his/her own work.

5. High School team projects must have no more than 3 members.

6. A student may not enter the same project twice. Research continued from a previous year's project is acceptable, provided there has been significant progress made from the previous year's work. Such projects must conform to the ISEF rules and regulations for continued research and will require the completion of Continuation Projects Form (7).

7. It is highly recommended that you make a copy of all your submitted paperwork for your records.

8. On the day of competition, each project must be approved by the Safety and Display Committee before the project is considered ready for judging. The project boards may be set up by someone other than the student, if the student cannot be in attendance.

9. Please note that items and materials that may be acceptable parts of the experimentation process may not be acceptable as part of the exhibit.

10. It is the responsibility of each entrant to familiarize themselves with the regulations and construct their exhibit accordingly.

11. Entrants must supply all the tools, thumbtacks, tape and other material necessary to set up their exhibit. **No part** of the exhibit may be attached to the walls of the exhibition building. Entrants must indicate the need for an electrical outlet on the registration form and must bring their own extension cord.

12. **Identification** of a student by name, address, telephone number, fax number, e-mail address or school affiliation on an exhibit is **prohibited**.

13. If the Display and Safety Committee finds that the exhibit in not in compliance with the rules and regulations, modifications may be made to bring the exhibit into compliance. If all modifications fail to bring the exhibit into compliance, it will be disqualified from the competition. Decisions made by the Display and Safety Committee are **final**.

14. Decisions on compliance of any exhibit or exhibit component are based on the ISEF/Region II Science & Engineering Fair rules and regulations found in this booklet.

15. Students must be present for the judges' interviews starting at the noted time on the day of the event. **Parents, teachers and non-exhibitors will not be allowed on the exhibit floor and may not coach, prompt or direct student actions during this judging process.** Call Dr. Leanne Frost at 406-771-4372 if you need us to make an exception in this regard.

16. Should it be a team project, not all members of the team need to be available during the judging process but it would be desirable. Designate one member of the team to be the principal spokesperson.

17. Handouts to judges must be limited to a one-page narrative (called the Abstract) that relates the essentials of the project. Such a handout may not contain any lists of accomplishments or acknowledgements.

18. All exhibits must be taken down and removed as noted in the event schedule. Items found after the event will become the property of the Region II Science & Engineering Fair if the rightful owner is not found within one week of the event.

19. Science Fair sponsors, staff and volunteers assume no responsibility for any loss or damage to an exhibit, exhibit materials or the personal possessions of a participant or visitor.

The Judging Process

On **the day of the fair**, at the time noted on the event schedule, your science fair project will be judged by at least three (3) judges. All of our judges are volunteers from our community who love science and math and wish to promote its appreciation among our local elementary, middle, and high school students.

Each judge will come individually to interview you for about 5 – 15 minutes. You will be asked questions about your research and your project will be judged for both your oral presentation as well as the quality of your exhibit.

You must have **three (3) regular judges** sign your sheet before you can consider judging to be complete. However, during this time, another group of **"Special Award"** judges may want to interview you as well.

You will be awarded points based on your knowledge of your project, your creativity and your use of the scientific method or engineering design process. You may provide a one-page written summary of your project to each judge. *The judging worksheet used by our judges is provided as an appendix to this handbook. You can use it as a guide for designing your experiment.

Since each one of the regular Science Fair judges will have to interview from 6 to 8 students, it may take up to one hour before the mandatory three regular judges have interviewed you and signed your judging sheet. Only then can you leave. However, if you leave, you may miss an interview with a "Special Award" judge. Therefore, it is recommended you plan to remain with your exhibit until the end of judging per the schedule.

All awards will be presented at the **Awards Ceremony** on the day of the event.

Special Awards and Project Rubrics may be found at:
Project Rubrics

- High School (http://gfcmsu.edu/sciencefair/documents/HighSchool_General_Rubric.pdf)
- Middle School (http://gfcmsu.edu/sciencefair/documents/MiddleSchool_General_Rubric.pdf)
- Elementary School (http://gfcmsu.edu/sciencefair/documents/Elementary%20_General_Rubric.pdf)

Display and Safety Regulations

The Display and Safety Committee is the final authority on display and safety issues for projects approved by the Region II Science & Engineering Fair Coordinator to compete. The Display and Safety Committee's point of reference will be the latest edition of the Intel ISEF Display and Safety Regulations (https://student.societyforscience.org/intel-isef-display-and-safety-regulations). Occasionally, the committee will require students to make revisions in their display to conform to the regulations.

Maximum Size of Exhibit

- Depth: 30 inches or 76 centimeters
- Width: 48 inches or 122 centimeters
- Height (floor to top): 108 inches or 274 centimeters. Fair-provided tables will not exceed a height of 30 inches or 76 centimeters.

Maximum exhibit sizes include all project materials and supports. If a table is used, it becomes part of the exhibit and must not itself exceed the allowed dimensions nor may the table plus any part of the exhibit exceed the allowed dimensions. Any project with a component that will be demonstrated must be demonstrated only within the confines of the booth. When not being demonstrated, the component plus project must not exceed the allowed dimensions.

Handouts

Handouts to judges must be limited to the photocopies of the abstract. A project book and research papers are not required to be at the booth for review by the judges but are highly recommended.

Not Allowed at Exhibit or in Booth

1. Living organisms, including plants
2. Glass
3. Soil, sand, rock, cement and/or waste samples, **even if permanently encased in a slab of acrylic**
4. Taxidermy specimens or parts
5. Preserved vertebrate or invertebrate animals
6. Human or animal food
7. Human/animal parts or body fluids (for example, blood, urine)
8. Plant materials (living, dead, or preserved) that are in their raw, unprocessed, or non-manufactured state
9. All chemicals including water. Absolutely no liquids can be utilized in the Project Display.
10. All hazardous substances or devices (Example: poisons, drugs, firearms, weapons, ammunition, reloading devices, grease/oil and sublimating solids such as dry ice)
11. Items that may have contained or been in contact with hazardous chemicals (Exception: Item may be permitted if professionally cleaned and document for such cleaning is available). Filters (including microbial) may not be displayed unless the Display & Safety Committee can reasonably determine that the device was cleaned or was never used (please include receipts in your notebooks and/or logbooks).
12. Sharp items (for example, syringes, needles, pipettes, knives)
13. Flames and highly flammable materials
14. Batteries with open-top cells or wet cells
15. Drones or any flight-capable apparatus unless the propulsion power source is removed
16. 3D Printers unless the power source is removed
17. Inadequately insulated apparatus capable of producing dangerous temperatures are not permitted
18. Any apparatus with belts, pulleys, chains, or moving parts with tension or pinch points that are not appropriately shielded
19. Any display items that are deemed distracting (i.e. sounds, lights, odors, etc.)
20. Personal items or packaging materials stored underneath the booth
21. Any apparatus deemed unsafe by the Scientific Review Committee, the Display and Safety Committee, or Society for Science & the Public (Example: large vacuum tubes or dangerous ray-generating devices, empty tanks that previously contained combustible liquids or gases, pressurized tanks, etc.

Photograph/Image Display Requirements

Any photograph/visual image/chart/table or graph is allowed if:

1. It is not deemed offensive or inappropriate by the Scientific Review Committee and the Display and Safety Committee. This includes, but is not limited to, visually offensive photographs or visual depictions of invertebrate or vertebrate animals, including humans. The decision by any one of the groups mentioned above is final.
2. It has a credit line of origin ("Photograph taken by..." or "Image taken from..."). (If all photographs being displayed were taken by the Entrant or are from the same source, one credit line prominently and vertically displayed is sufficient.)
3. It is from the Internet, magazines, newspapers, journals, etc., and credit lines are attached. (If all photographs/images are from the same source, one credit prominently and vertically displayed is sufficient.)
4. It is a photograph or visual depiction of the Entrant.
5. It is a photograph or visual depiction of a human subject for which a signed consent form is at the project or in the booth. (Photograph release signed by the human subject must be included in the paperwork.)

Laser Requirements

Lasers may be used in a display under the following guidelines.

- Class 1 and Class 2 lasers are allowed provided the student avoids indiscriminate exposure to others (except if passed through magnifying optics such as microscopes and telescopes, in which case they may not be used). No other lasers may be used or displayed.

Other Safety Regulations

1. Any inadequately insulated apparatus producing extreme temperatures that may cause physical burns is not allowed.
2. Any apparatus with unshielded belts, pulleys, chains or moving parts with tension or pinch points must be for display purposes only.
3. The Display and Safety Committee reserves the right to remove any project for safety reasons.
4. Project sounds, lights, odors or any other display items must not be distracting. Exceptions to this rule may be permitted for judging demonstrations. Approval must be given prior to judging.

Electrical Regulations

1. Cord-connected electrical appliances shall be UL/CSA approved. Cord components should be listed with UL or CSA.
2. Electrical devices must be protectively enclosed. Any enclosure must be non-combustible. All external non-current carrying metal parts must be grounded using the above listed UL/CSA connection and materials.
3. Entrants requiring 120 or 220 Volt A.C. electrical circuits must provide a **UL-listed 3-wire extension cord** which is appropriate for the load and equipment and is in good repair.
   Electrical power supplied to projects and, therefore, the maximums allowed for projects is **120** or **220 Volt, A.C., single phase, 60 cycle.** No multi-phase will be available or shall be used. For all electrical regulations, **"120 Volt A.C." or "220 Volt A.C."** is intended to encompass the corresponding range of voltage as supplied by the facility in which the Science Expo is being held.
4. All electrical connectors, wiring, switches, extension cords, fuses, etc. must be **UL-listed** and must be appropriate for the load and equipment. Connections must be soldered or made with **UL-listed** connectors. Wiring, switches, and metal parts must have adequate insulation and over- current safety devices (such as fuses) and must be inaccessible to anyone other than the entrant. Exposed electrical equipment or metal that possibly may be energized must be shielded with a non-conducting material or with a grounded metal box to prevent accidental contact.

5. All lighting used for decoration or illumination must be UL/CSA approved. Lamp wattage must not exceed ratings. Lighting must not pose risk of injury if touched. As low a voltage as possible must be used.
6. At the end of the viewing period, all electrical exhibits must be disconnected and power bars must be switched off.
7. Where practical and necessary, it is recommended that indicator lights be used to indicate that the voltage is on.
8. An insulating grommet is required at the point where the wire or cable enters any enclosure.
9. No exposed live parts over 36 volts are allowed.
10. There must be an accessible, clearly visible on/off switch or other means of quickly disconnecting from the **120 or 220 Volt** power source.
11. Wet cells shall not be used because of the hazardous chemicals involved.

Other Information and Requirements

1. It is desirable that ***entrants be present at their projects*** for the Display and Safety inspection.
2. No changes, modifications, or additions to projects may be made after approval by the Display and Safety Committee.
3. The Display and Safety Committee reserves the right to remove any project for safety reasons or to protect the integrity of the Science Expo and its rules and regulations.
4. Entrants using audio-visual or multi-media presentations (for example, 35mm slides; videotapes; images, graphics, animations, etc., displayed on computer monitors; or other non-print presentation methods) must be prepared to show the entire presentation to the Display and Safety inspectors before the project is approved.
5. If a project fails to qualify and is not removed by the Entrant, the Display & Safety Committee will remove the project in the safest manner possible but is not responsible for damage to the project.
6. Any disks, CDs, printed materials, etc. (other than the abstract) designed to be distributed to judges or the public will be confiscated by the Display and Safety Committee and will be discarded immediately.
7. Project sounds, lights, odors, or any other display items must not be distracting.
8. No food or drinks, except small containers of bottled water for personal consumption, are allowed in the Exhibit Hall.

Human Participants

When students conduct research with humans, the rights and welfare of the participants must be protected.

The following are **exempt**:

- Testing of a student-designed invention, program, concept, etc. where the feedback received is a direct reference to the product, where personal data is not collected and where the testing does not pose a health or safety hazard.
- When data is taken from pre-existing information that is publically available and does not involve any interaction with humans.
- Behavioral observations in public settings (e.g. shopping mall, public park) where the researcher
  a) has no interaction with the individuals observed
  b) does not manipulate the environment in any way
  c) does not record any personally identifiable data.
- The student receives data in a de-identified/anonymous format from a professional and the Science Expo ensures that the data were appropriately de-identified by review of the written documentation.

The requirement for documentation of written informed consent/assent/parental permission is **waived** if the research involves only minimal risk and anonymous data collection and is one of the following:

- Research involving normal educational practices
- Research on individual or group behavior or characteristics of individuals where the researcher does not manipulate the participants' behavior and the study does not involve more than minimal risk.
- Surveys, questionnaires or activities involve perception, cognition, or game theory and does not involve gathering personal information, invasion of privacy or potential for emotional distress.
- Studies involving physical activity have no more than minimal risk and the probability and magnitude of harm or discomfort is not anticipated to be greater than those ordinarily encountered in DAILY LIFE or during performance of routine physical activities.

If there is any uncertainty, it is recommended that documentation of written formal consent/assent/parental permission be obtained.

Informed consent requires that the researcher provides complete information to the participant (and/or parents or guardians) about the risks and benefits associated with participation in the research study. Participants must be informed their participation is voluntary and they are free to stop participating at any time. When written parental permission is required and the study is a survey, the survey must be attached to the consent form.

Vertebrate Animals

Vertebrate animals are defined as:

- Live, nonhuman vertebrate mammalian embryos or fetuses
- Tadpoles
- Bird and reptile eggs within 72 hours of hatching
- All other nonhuman vertebrates (including fish) at hatching or birth

The use of non-animal research methods is strongly endorsed and students are encouraged to use alternatives to animal research. When students conduct research with animal subjects, health and well- being are of high priority.

Vertebrate animal studies may be conducted at a home, school, farm, ranch, in the field, etc. This includes:

- Studies of animals in their natural environment
- Studies of animals in zoological parks
- Studies of livestock that use standard agricultural practices.
- Studies of fish that use standard aquaculture practices.

These projects must adhere to BOTH of the following guidelines:

1. The research involves only agricultural, behavioral, observational or supplemental nutritional studies on animals, **AND**
2. The research involves only non-invasive and non-intrusive methods that do not negatively affect an animal's health or well-being.

Studies that cause more than momentary or slight pain or distress are prohibited. Animal deaths due to experimental procedures are prohibited.

Animals may not be captured from or released into the wild without approval of authorized wildlife or other regulatory officials. Fish may be obtained from the wild only if the researcher releases the fish unharmed, has the proper license and adheres to state, local and national fishing laws and regulations.

A Qualified Scientist or Designated Supervisor must directly supervise all research involving vertebrate animals, expect for observational studies where there is no interaction with the animals being observed and there is no manipulation of the animal's environment in any way.

Animal subjects must be treated kindly and cared for properly.

Review the following ISEF Rules for more information:

- Human Participants
- Vertebrate Animals
- Potentially Hazardous Biological Agents
- Hazardous Chemicals, Activities, or Devices

Potentially Hazardous Biological Agents:

Rules for use of microorganisms (including bacteria, viruses, viroids, prions, rickettsia, fungi and parasites), recombinant DNA technologies or human or animal fresh/frozen tissues, blood or bodily fluids.

The following types of studies are exempt from review and require no additional forms:

- Studies involving baker's yeast and brewer's yeast, except in rDNA studies.
- Studies involving Lactobacillus thurgensis, nitrogen-fixing, oil-eating bacteria and algae-eating bacteria introduced into their natural environment. (Not exempt if cultured in a petri dish environment.)
- Studies involving water or soil not concentrated in media conducive to their growth.
- Studies of mold growth on food items if the experiment is terminated at the first evidence of mold.
- Studies of mushrooms and slime molds.
- Studies involving E. coli k-12 which are done at school and are not recombinant DNA studies.

The following types of studies are exempt from prior review but require a **Risk Assessment Form (3)**:

- Studies involving protists, archaea, and similar microorganisms
- Research using manure for composting, fuel production, or other non-culturing experiments.
- Commercially-available color change coliform water test kits. These kits must remain sealed and must be properly disposed.
- Studies involving decomposition of vertebrate organisms (such as in forensic projects).
- Studies with microbial fuel cells.

The use of potentially hazardous microorganisms is allowable as follows:

- The Science Expo approves the research plan before experimentation begins. The initial risk assessment determined by the student researcher and adults supervising the project must be confirmed by the Expo.

- Experimentation involving the culturing of potentially hazardous biological agents, even Bio-Safety Level 1 organisms is prohibited in a home environment. However, specimens may be collected at home as long as they are immediately transported to a laboratory with BSL 1 containment.
- Research in a BSL-1 laboratory must be supervised by a trained Designated Supervisor or a Qualified Scientist. The student must be properly trained in standard microbiological practices.
- Naturally occurring plant pathogens may be studied (not cultured) at home but may not be introduced into a home/garden environment.
- The culturing of human or animal waste, including sewage sludge, is considered a BSL-2 study.
- All potentially hazardous biological agents must be properly disposed at the end of experimentation with their bio-safety level. For BSL-1 or BSL-2 organisms: autoclave at 121 degrees Celsius for 20 minutes, use of a 10% bleach solution (1:10 dilution of domestic bleach), incineration, alkaline hydrolysis, bio-safety pickup and other manufacturer recommendations are acceptable.

See https://student.societyforscience.org/Potentially-Hazardous-Biological-Agents for more information.

Additional Rules for Projects Involving Unknown Microorganisms

Studies involving unknown microorganisms present a challenge because the presence, concentration and pathogenicity of possible agents are unknown. In science fair projects, these studies typically involve the collection and culturing of microorganisms from the environment (e.g. soil, household surfaces, skin.)

1) Research with unknown microorganisms can be treated as a BSL-1 study under the following conditions:
   a. Organism is cultured in a plastic petri dish (or other standard non-breakable container) and sealed. Other acceptable containment includes two heavy-duty (2-ply) sealed bags.
   b. Experiment involves only procedures in which the Petri dish remains sealed throughout the experiment (e.g., counting presence of organisms or colonies).
   c. The sealed Petri dish is disposed of via autoclaving or disinfection under the supervision of the Designated Supervisor.
2) If a culture container with unknown microorganisms is opened for any purpose, (except for disinfection for disposal), it must be treated as a BSL-2 study and involve BSL-2 laboratory procedures.

Additional Rules for Projects Involving Recombinant DNA (rDNA) Technologies Studies involving rDNA

technologies in which microorganisms have been genetically modified require close review to assess the risk level assignment. Some rDNA studies can be safely conducted in a BSL-1 high school laboratory with prior review by a knowledgeable SRC:

1) All rDNA technology studies involving BSL-1 organisms and BSL-1 host vector systems must be conducted in a BSL-1 laboratory under the supervision of a Qualified Scientist or Designated Supervisor and must be approved by the SRC prior to experimentation. Examples include cloning of DNA in *E. coli* K12, *S. cerevesiae,* and *B. subtilis* host-vector systems.
2) Commercially available rDNA kits using BSL-1 organisms may be conducted in a BSL-1 laboratory under the supervision of a Qualified Scientist or trained Designated Supervisor and must be approved by the SRC prior to experimentation.
3) An rDNA technology study using BSL-1 agents that may convert to BSL-2 agents during the course of experimentation must be conducted entirely in a BSL-2 facility.
4) All rDNA technology studies involving BSL-2 organisms and/or BSL-2 host vector systems must be conducted in a Regulated Research Institution and approved by the IBC prior to experimentation.
5) Propagation of recombinants containing DNA coding for oncogenes or other human, plant or animal toxins (including viruses) is prohibited.

Additional Rules for Projects with Tissues and Body Fluids, including Blood and Blood Products

Studies involving fresh/frozen tissue, blood or body fluids obtained from humans and/or vertebrates may contain microorganisms and have the potential of causing disease. Therefore, a proper risk assessment is required.

1) *The following types of tissue do not need to be treated as potentially hazardous biological agents:*
   a. Plant tissue
   b. Plant and non-primate established cell lines and tissue culture collections (e.g., obtained from the American Type Culture Collection). The source and/or catalog number of the cultures must be identified in the Research Plan.
   c. Fresh or frozen meat, meat by-products, pasteurized milk or eggs obtained from food stores, restaurants, or packing houses.
   d. Hair, hooves, nails and feathers.
   e. Teeth that have been sterilized to kill any blood- borne pathogen that may be present. Chemical disinfection or autoclaving at 121 degrees Celsius for 20 minutes is recommended.
   f. Fossilized tissue or archeological specimens.
   g. Prepared fixed tissue

Hazardous Chemicals, Activities or Devices:

(includes DEA-controlled substances, prescription drugs, alcohol & tobacco, firearms, and explosives, radiation, lasers, etc.)

The following rules apply to research using hazardous chemicals, devices and activities that are most often restricted of their use by minors. Hazardous activities are those that involve a level of risk above and beyond that encountered in the student's everyday life.

These rules are intended to protect the student researcher by ensuring proper supervision and the consideration of all potential risks so that appropriate safety precautions are taken.

Rules for ALL projects involving Hazardous Chemicals, Activities and Devices:

- The use of hazardous chemicals and devices and involvement in hazardous activities require direct supervision by a Designated Supervisor, except those involving DEA-controlled substances, which require supervision by a Qualified Scientist.
- A risk assessment must be conducted by the student and Designated Supervisor prior to experimentation and documented on the Risk Assessment Form (3).
- The student researcher must minimize the impact of the experiment on the environment.

For the complete Rules for Specific Regulated Substances:

DEA-controlled Substances
Prescription Drugs
Alcohol and Tobacco Firearms and Explosives

Please refer to https://student.societyforscience.org/hazardous-chemicals-activities-or-devices for detailed information.

However,

- Production of ethyl alcohol (wine or beer) is allowable in the home under parental supervision and must meet the TTB (Alcohol and Tobacco Tax and Trade Bureau) home production regulations.
- Fermentation studies in which minute quantities of ethyl alcohol are produced are permitted.
- Students are allowed to distill alcohol for fuel or other non-consumable products. The work must be conducted at school and a TTB permit must be obtained by school authorities.
- Projects involving firearms and explosives are allowable when conducted with the direct supervision of a

Designated Supervisor and when in compliance with all federal, state and local laws.

- A fully assembled rocket motor, reload kit or propellant modules containing more than 62.5 grams of propellant are subject to the permitting, storage and other requirements of federal explosive laws and regulations.
- Potato guns and paintball guns are not firearms unless they are intended to be used as weapons. They must be treated as hazardous devices.

Hazardous Chemicals

A proper risk assessment of chemicals must include review of the following factors:

- ***Toxicity*** – the tendency of a chemical to be hazardous to health when inhaled, swallowed, injected or in contact with the skin.
- ***Reactivity*** — the tendency of a chemical to undergo chemical change.
- ***Flammability*** — the tendency of a chemical to give off vapors which readily ignite when used under normal working conditions.
- ***Corrosiveness*** — the tendency of a chemical, upon physical contact, to harm or destroy living tissues or physical equipment.

When assessing risk, the type and amount of exposure to a chemical must be considered. For example, an individual's allergic and genetic disposition may have an influence on the overall effect of the chemical. The student researcher must refer to Material Safety Data Sheets provided by the vendor (MSDS) to ensure that proper safety precautions are taken. Some MSDS sheets (e.g., Flinn) rank the degree of hazard associated with a chemical. This rating may assist students and adult sponsors in determining risk associated with the use of a chemical.

A risk assessment must include proper disposal methods for the chemicals used in an experiment. The Flinn Catalog (referenced in the Sources of Information section found in the High School Handbook) provides information for the proper disposal of chemicals. If applicable, the student researcher must incorporate in the research plan disposal procedure required by federal and state guidelines.

Hazardous Devices

The documentation of Risk Assessment (Form 3) is required when a student researcher works with potentially hazardous/dangerous equipment and/or other devices, in or outside a laboratory setting that require a moderate to high level of expertise to ensure their safe usage. Some commonly used devices (Bunsen burners, hot plates, saws, drills, etc.) may not require a documented risk assessment, assuming that the student researcher has experience working with the device. Use of other potentially dangerous devices such as high vacuum equipment, heated oil baths, NMR equipment, and high temperature ovens must have documentation of a risk assessment.

It is recommended that all student designed inventions also have documentation of a risk assessment.

Radiation

A risk assessment must be conducted when a student uses non-ionizing radiation beyond that normally encountered in everyday life. Non-ionizing radiation includes the spectrum of ultraviolet (UV), visible light, infrared (IR), microwave (MW), radiofrequency (RF) and extremely low frequency (ELF).
Lasers usually emit visible, ultraviolet or infrared radiation. Lasers are classified into four classes based upon their safety. Manufacturers are required to label Classes II – IV lasers.

Class I lasers – those found in CD players, laser printers, geological survey equipment and some laboratory equipment. There are no known risks associated with using a Class I laser.

Class II lasers – found in laser pointers, aiming and range-finding devices. These pose a risk if the beam is viewed directly over a long period of time.

Class III lasers – found in higher-powered laser pointers, printers and spectrometers. They are hazardous devices

which can cause eye damage when the beam is viewed directly even for a short period of time.

Class IV lasers – high powered lasers used in surgery, research, and industry. They are extremely hazardous and can cause eye and skin damage from both direct and indirect exposure. The beam is also a fire hazard.

Projects involving radionuclides (radioisotopes) and X-rays must involve a careful examination of the risks associated with the study. Depending upon the level of exposure, radiation released from these sources can be a health hazard. Most research institutions have a Radiation Safety Office which oversees the use of ionizing radiation and ensures compliance with state and federal regulations.

For the complete set of rules, go to the https://student.societyforscience.org/rules-all-projects page.