MARIAN HIGH SCHOOL
SCIENCE RESEARCH GUIDE

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"The Ultimate Hands-on Experience"

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Introduction

Science is the study of the world around us. Through science, we discover how things work, and how to modify things around us. The work that is done through science must be made known to all. This is done by means of the science research presentation. Described in this booklet, you will find all you need to know in order to develop a proper science research report and project. By following the material outlined here, you should be well on your way to producing a top-quality product and to learning how science is done.

Scientific Method

Scientists have a set procedure for finding out how the world works. It is called The Scientific Method. All scientists follow this method in their work. Since most of you have previously been exposed to scientific method, it is presented here as a short outline. The individual steps will be expanded on in future sections of this booklet.

A. Choose problem
1. Ask questions about problem
2. Do some general research

B. Form hypothesis (educated guess)
1. Do more detailed research
2. Plan experiment(s)

C. Experimentation
1. Set up control for comparison
2. Make complete lists of procedures and materials

D. Data Collection
1. Take careful notes and photographs
2. Set up graphs, charts & tables

E. Repeat Experiment (steps C and D)

F. Data Interpretation
1. Summarize results
2. Draw conclusions
3. Analyze

G. Prepare report, project and presentation

I. Experimental Project Design

A. Controlled experiments

By far, the most worthwhile and usable experiments are controlled experiments. These are experiments set up in duplicate in order to have a valid basis for comparing changes. In the controlled experiment, two setups are put together. (More, if more than one characteristic is being tested.) One setup -the control group- is not changed in any way from the regular, natural conditions. Any other setups -experimental groups - differ from the control in **only one** condition. For example, if I wish to find out which color of light provides the best growth conditions for a plant, I would have several setups. Each would have the same conditions, except for the color of light. I would have to use the same size and variety of plant, the same size pot, same soil type and amount, same water amount and frequency, same fertilization schedule, and same amount of light. My only change could be a regular white light for the control, and red, green, blue, etc., lights for the experimental group. There are some types of experiments in which a control is not possible. The important thing to remember with these is that you **can only test one condition, or variable, at a time**.

SOURCES OF INFORMATION FOR ALL PROJECTS

1. United States Patent and Trade Office Customer Service: 1-800-786-9199 (toll-free); 571-272-1000 (local); 571-272-9950 (TTY) uspto.gov uspto.gov/patents/process/index.jsp
   Conducting a Patent Search:
   • https://patents.google.com/
   • http://www.freepatentsonline.com/
   • https://worldwide.espacenet.com/
2. USPTO Resources
   • 7 Step Search Strategy Guide and Video Tutorial https://www.uspto.gov/learning-resources
   • Pro Bono Program https://www.uspto.gov/patents-getting-started/using-legalservices/pro-bono/patent-pro-bono-program
   • Law School Clinic Certification Program uspto.gov/learning-and-resources/ip-policy/publicinformation-about-practitioners/law-school-clinic-1
   • USPTO Pro Se Assistance Program https://www.uspto.gov/learning-and-resources/newsletter/inventors-eye/pro-se-assistance-program
3. European Patent Office www.epo.org www.epo.org/applying/basics.html
4. Plagiarism and Ethics https://resourcecenter.cis.ieee.org/ https://www.scribbr.com/plagiarism-checker/
5. Aquatic Nuisance Species (ANS) Task Force www.anstaskforce.gov https://www.fws.gov/program/aquatic-nuisance-speciestask-force/documents
6. APHIS
   https://www.aphis.usda.gov/aphis/ourfocus/wildlifedamage/operational-activities/SA_Invasive/CT_Invasive_species1
   Animal and Plant Health Inspection Service Invasive Species List https://www.aphis.usda.gov/aphis/resources/pests-diseases
   Agricultural Pests and Diseases
7. Invasive Species Specialist Group http://www.iucngisd.org/gisd/ The Global Invasive Species database contains invasive species information supplied by experts from around the world.
8. Invasive Species Information www.invasivespeciesinfo.gov/resources/lists.shtml Provides information for species declared invasive, noxious, prohibited, or harmful or potentially harmful.

B. Special Problems (from *International Rules for Pre-College Science Research: Guidelines for Science and Engineering Fairs 2025–2026* by Society for Science & the Public)

All forms referenced here may be found at
https://www.societyforscience.org/isef/forms/

There are four broad categories of study that may cause some problems in a science research program. At the very least, International and Marian rules require that more care and paperwork be involved in these areas. While we are not trying to keep you from working in these areas, we do want to let you know that projects of these types do require more work and supervision.

1. Human Participants

The effects of alcohol or any controlled or prescription substances on humans is not allowed.

The following rules were developed to help pre-college student researchers adhere to the federal regulations governing professional scientists and to protect the welfare of both human participants and the student researcher. Health and well-being is of the highest priority when students conduct research with human participants.

According to Code of Federal Regulation 45, CFR 46, a human participant is a living individual about whom an investigator conducting research obtains (1) data or samples through intervention or interaction with individuals(s) or (2) identifiable private information.

Examples of projects that are considered "human participant research" include:

- Studies in which the researcher interacts with another human for purposes of their study
- Participants in physical activities (e.g., physical exertion, ingestion of any substance, any medical procedure)
- Psychological, educational and opinion studies (e.g., surveys, questionnaires, tests)
- Studies in which the researcher is the subject of the research
- Testing of student designed invention, prototype or computer application by human participants other than student researcher
- Data/record review projects that include data that are not de- identified/anonymous (e.g., data set that includes name, birth date, phone number or other identifying variables)
- Behavioral observations that
    - involve any interaction with the observed individual(s) or where the researcher has modified the environment (e.g., post a sign, place an object).
    - occur in non-public or restricted access settings (e.g., day care setting, doctor's office)
    - involve the recording of personally identifiable information.

All human participant studies must be reviewed and approved by an Institutional Review Board (IRB) prior to experimentation. An IRB must consist of a minimum of three members including the following:
• An educator (not the teacher that is serving as the Adult Sponsor)
• A school administrator (preferably principal or vice principal)
• A medical or mental health professional.

Student researchers must complete ALL elements of the Human Participants portion of the Research Plan/Project Summary Instructions and evaluate and minimize the physical, psychological and privacy risks to their human participants. See Risk Assessment information on page 9 and the online Risk Assessment Guide (https://www.societyforscience.org/isef/international-rules/human-participants/#riskassess) for additional guidance.

Prohibited Studies

1. Students are prohibited from independently diagnosing any human condition, illness or disease, administering medication, and/or performing medical procedures on human participants.
    a. Students are prohibited from drawing blood or conducting any other medical procedures on anyone except themselves.
    b. Students are prohibited from providing advice, diagnostic or medical information to participants without direct supervision and involvement of a medical professional.
    c. Students are prohibited from publishing diagnostic apps on public websites or app stores without appropriate FDA approvals.
    d. Students are prohibited from disclosing results or data from their study to the human participants.
2. Student researchers may NOT publish or display information in a report that identifies the human participants directly or through identifiers linked to the participants (including photographs) without the written consent of the participant(s) (Public Health Service Act, 42, USC 241 (d)).

Rules

1. Student research involving human participants must be reviewed and approved by an Institutional Review Board (IRB) before any interaction (e.g., recruitment, data collection) with human participants may begin. An IRB will determine any additional supervision required, make any adjustments to the research plan and designate the risk and consent processes required.

2. A consent process is required. Participation in research may begin only after participants have voluntarily given informed consent/assent (and in many cases received parental permission).

a. Adult research participants may give their own consent.

b. All human participant studies involving minors (students under 18 years of age) must receive assent from the student participant and written parental permission from a legal guardian.

c. For studies involving minors, if the study includes a survey, the survey must be attached to the consent form as part of the written parental permission process.

d. Informed consent requires that the researcher provides complete information to the participant (and where applicable, parents or guardians) about the risks and benefits associated with participation in the research study, which then allows the participants and parents or guardians to make an informed decision about whether or not to participate.

e. Participants must be informed that their participation is voluntary and that they are free to stop participating at any time (i.e., they may participate or decline to participate, with no adverse consequences of non- participation or aborted participation).

f. Informed consent may not involve coercion.

g. A student researcher may request that the IRB waive the requirement for written informed consent from adult participants (over the age of 18) if the research involves only minimal risk and anonymous data collection.

3. The research study must be in compliance with all privacy laws (e.g., U.S. Family Educational Rights and Privacy Act (FERPA) and the U.S. Health Insurance Portability and Accountability Act (HIPAA)) when they apply to the project (e.g. the project involves medical information).

4. A student may observe and collect data for analysis of medical procedures, medication/treatment efficacy, and diagnosis of illness, only under the direct supervision of a licensed health care provider/ professional. This Healthcare provider/professional must be named in the research plan/ protocol approved by the IRB. The IRB must also confirm that the student is not violating the appropriate practice act (medical, nursing, pharmacy, etc) of the state or country in which he/she is conducting the research.

5. All published instruments that are not in the public domain must be administered, scored and interpreted by a Qualified Scientist as required by the instrument publisher. Any and all use and distribution of the test must be in accordance with the publisher's requirements, including procurement of legal copies of the instrument.

6. Studies that involve recruitment and interaction with human participants online or via the internet are allowed if they adhere to all of the human participant rules above regarding consent processes and restrictions, including obtaining written parental permission for studies involving minors. In order to protect the confidentiality of the participants, it is extremely important that IP addresses, as well as the data provided, be safeguarded.

7. Student-designed invention, prototype, computer application, engineering/design projects and product testing that involve testing of the invention or consumer product by any human participant require attention to the potential risks to the individual(s) testing or trying out the invention/prototype.

a. IRB review and pre-approval is required when the student- designed invention, prototype, application, etc. is tested by human participants other than the student researcher(s) or a single adult guardian/ adult sponsor/QS/DS when the testing requires an adult tester (such as driving or other age-restricted activities). This includes surveys conducted regarding potential use or opinions of the invention or consumer product by the general public. This is not intended to apply to receiving professional feedback from experts in the field of study prior to experimentation.

b. Human participants testing of an invention, prototype or project that involves a medical diagnosis or intervention (as defined by the FDA or Medical Practices Act) must adhere to the prohibition of medical procedures (see Prohibited Studies) and be supervised by a health care professional with appropriate credentials and specialization in the area of medical diagnosis or intervention being studied.

DOCUMENTATION AND APPROVAL

1. Student researchers must have a Research Plan that includes all of the standard elements as well as the following areas specific to human participant research:

a. **Participants:**

- Describe age range, gender, racial/ethnic composition of participants.
- Identify vulnerable populations (minors, pregnant women, prisoners, mentally disabled or economically disadvantaged).

b. **Recruitment:**

- Where will you find your participants?
- How will they be invited to participate?

c. **Methods:**

• What will participants be asked to do?

• Will you use any surveys, questionnaires or tests? If yes and not your own, how did you obtain? Did it require permissions? If so, explain.

• What is the frequency and length of time involved for each subject?

d. **Risk Assessment:**

• What are the risks or potential discomforts (physical, psychological, time involved, social, legal, etc.) to participants?

• How will you minimize risks?

• List any benefits to society or participants.

e. **Protection of Privacy:**

• Will identifiable information (e.g., names, telephone numbers, birth dates, email addresses) be collected?

• Will data be confidential/anonymous?

• If anonymous, describe how the data will be collected.

• If not anonymous, what procedures are in place for safeguarding confidentiality?

• Where will data be stored? Who will have access to the data?

• What will you do with the data after the study?

f. **Informed Consent Process:**

• Describe how you will inform participants about the purpose of the study what they will be asked to do, that their participation is voluntary and they have the right to stop at any time.

• If participants are minors, explain the process by which written parental permission will be received and a parent will have access to the survey instrument prior to providing permission.

2. Student research involving human participants must be reviewed and approved by an IRB before any interaction (e.g., recruitment, data collection) with human participants may begin. It is the responsibility of the IRB to evaluate potential physical and/ or psychological risks of the project and make a determination about whether the project is appropriate for student research and safe for the student researcher and participants.

a. Projects that are conducted at school, at home or in the community that are not affiliated with a Regulated Research Institution (RRI) must be reviewed and approved by the School IRB before the student may begin recruiting and/or interacting with human participants.

b. The School IRB (or SRC/IRB from your affiliate fair) must assess the risk and document its determination of risk on Form 4.

c. Projects that are conducted at an RRI (e.g., university, hospital, medical center, government lab) must have IRB approval from the RRI. A copy of the IRB approval for the project must be obtained.

d. A letter from an adult mentor and/or Qualified Scientist is not sufficient documentation of the RRI IRB review and approval process.

3. When working with a facility for protected groups where participants live or attend programming (e.g. retirement home, daycare, prison, etc.) written approval from the facility must be obtained prior to experimentation, as well as informed consents for the individual participants.

4. The student must comply with all determinations made by the School or RRI IRB before beginning any interaction with human participants (e.g., recruitment, data collection).

a. If the IRB requires a Qualified Scientist (QS), Form 2 must be completed by the QS before any interaction with human participants. The School IRB will review this completed form before approving the project.

b. If the IRB requires a Direct Supervisor (DS), Form 3 must be completed before any interaction with human participants. The School IRB will review this completed form before approving the project.

5. After initial IRB approval, a student with any proposed changes in the Research Plan must repeat the approval process and regain approval before resuming interaction (recruitment, data collection) with human participants.

6. After experimentation and before competition, the Affiliated Fair SRC will review for compliance with all rules.

7. The following forms are required for studies involving human participants:

» Checklist for Adult Sponsor (1)

» Student Checklist (1A)

» Research Plan/Project Summary

» Approval Form (1B)

» Human Participants Form (4) for projects reviewed by school IRB or IRB approval documentation from an RRI » Informed Consents/Parental Permission, when applicable

» Copies of any surveys, when applicable

» Regulated Research Institution Form (1C), when applicable

» Qualified Scientist Form (2), when applicable

» Risk Assessment (3) when applicable 8. Risk Assessment Form 3 is required for all projects that involve human participant testing of any project involving student-designed inventions, prototypes or consumer products.

EXEMPT STUDIES (DO NOT REQUIRE IRB PREAPPROVAL OR HUMAN PARTICIPANTS PAPERWORK) Some studies involving humans are exempt from IRB preapproval or additional human participant forms. Exempt projects for ISEF and affiliated fairs are:

1. Student-designed Invention, Prototype, Computer Applications, Engineering/Design Project or Consumer Product Testing in which the student researcher is the only person testing the invention, prototype, computer application or consumer product and the testing does not pose a health or safety hazard.
    a. The exemption can also apply when the human participant testing is a single adult guardian or Adult Sponsor/QS/DS when the testing requires an adult tester. (This is instead of the student researcher; not to supplement.)
    b. IRB review and pre-approval is required if the project involves more than the student researcher (or single adult guardian serving as the sole tester) or any introduction of a human variable or factor in the testing of a consumer product/invention/prototype/ application (e.g., amount of sleep, strength or endurance of tester, etc.).
2. Data/record review studies (e.g., baseball statistics, crime statistics) in which the data are taken from preexisting data sets that are publicly available and/ or published and do not involve any interaction with humans or the collection of any data from a human participant for the purpose of the student's research project.
3. Behavioral observations of unrestricted, public settings (e.g., shopping mall, public park) in which all of the following apply:
    a. the researcher has no interaction with the individuals being observed
    b. the researcher does not manipulate the environment in any way and
    c. the researcher does not record any personally identifiable data.
4. Projects in which the student receives pre-existing/ retrospective data in a de-identified/ anonymous format which complies with both of the following conditions:
    a. the professional providing the data certifies in writing that the data have been appropriately de-identified before being given to the student researcher and are in compliance with all privacy and HIPAA laws, and
    b. the affiliated fair SRC ensures that the data were appropriately de-identified by review of the written documentation provided by the supervising adult(s)

If there is any uncertainty regarding the appropriateness of waiving written informed consent/assent/parental permission, it is strongly recommended that documentation of written informed consent/assent/parental permission be obtained

HUMAN PARTICIPANT & IRB RESOURCES

Use this information to help determine the level of risk involved in a study involving human participants.

Human Participant Risk Assessment

All human participant projects are considered to have some level of risk.

No more than minimal risk exists when the probability and magnitude of harm or discomfort anticipated in the research are not greater (in and of themselves) than those ordinarily encountered in everyday life or during performance of routine physical or psychological examinations or tests.
More than minimal risk exists when the possibility of physical or psychological harm or harm related to breach of confidentiality or invasion of privacy is greater than what is typically encountered in everyday life. Most of these studies require documented informed consent or minor assent with the permission of parent or guardian (as applicable).

1) Examples of Greater than Minimal Physical Risk
a. Exercise other than ordinarily encountered in everyday life
b. Ingestion, tasting, smelling, or application of a substance. However, ingestion or tasting projects that involve commonly available food or drink will be evaluated by the IRB which determines risk level based upon the nature of the study and local norms.
c. Exposure to any potentially hazardous material.
2) Examples of Greater than Minimal Psychological Risk
A research activity (e.g. survey, questionnaire, viewing of stimuli) or experimental condition that could potentially result in emotional stress. Some examples include: answering questions related to personal experiences such as sexual or physical abuse, divorce, depression, anxiety; answering questions that could result in feelings of depression, anxiety, or low self-esteem; or viewing violent or distressing video images.
3) Privacy Concerns
a. The student researcher and IRB must consider whether an activity could potentially result in negative consequences for the participant due to invasion of privacy or breach of confidentiality. Protecting confidentiality requires measures to ensure that identifiable research data are not disclosed to the public or unauthorized individuals.
b. Risk level can be reduced by protecting confidentiality or collecting data that is strictly anonymous. This requires the collection of research in such a way that it is impossible to connect research data with the individual who provided the data.

4) Risk Groups
If the research study includes participants from any of the following groups, the IRB and student research must consider whether the nature of the study requires special protections or accommodations:
a. Any member of a group that is naturally at-risk (e.g. pregnant women, developmentally disabled persons, economically or educationally disadvantaged persons, individuals with diseases such as cancer, asthma, diabetes, AIDS, dyslexia, cardiac disorders, psychiatric disorders, learning disorders, etc.)
b. Special groups that are protected by federal regulations or guidelines (e.g. children/minors, prisoners, pregnant women, students receiving services under the Individuals with Disabilities Education Act (IDEA).
See the online Risk Assessment Guide (https://sspcdn.blob.core.windows.net/files/Documents/SEP/ISEF/Resources/Risk-Assessment-Guide.pdf) and Online Survey Consent Procedures (https://sspcdn.blob.core.windows.net/files/Documents/SEP/ISEF/Resources/Online-Survey-Consent-Procedures.pdf) for more detailed information on risk assessment. If the risk is more than minimal, a Risk Assessment Form 3 is required.

Sources of Information: Human Participants

1. Code of Federal Regulation (CFR), Title 45 (Public Welfare), Part 46-Protection of Human Subjects (45CFR46)
http://ohsr.od.nih.gov/guidelines/45cfr46.html

2. NIH tutorial, "Protecting Human Research Participants"
http://phrp.nihtraining.com/users/PHRP.pdf

3. Belmont Report, April 18, 1979
www.hhs.gov/ohrp/humansubjects/guidance/belmont.html

4. Standards for Educational and Psychological Testing. (1999). Washington, DC: AERA, APA, NCME.
www.apa.org/science/programs/testing/standards.aspx

5. American Psychological Association
750 First Street, NE Washington, DC 20002-4242
phone: 202-336-5500; 800-374-2721
www.apa.org

Information for students:
www.apa.org/science/leadership/students/information.aspx
Information regarding publications:
www.apa.org/pubs/index.aspx

6. Educational and Psychological Testing
Testing Office for the APA Science Directorate
phone: 202-336-6000
email: testing@apa.org
www.apa.org/science/programs/testing/index.aspx

7. The Children's Online Privacy Protection Act of 1998 (COPPA) (15 U.S.C. §§ 6501–6506)
www.ftc.gov/privacy/coppafaqs.shtm

2. Vertebrate Animals

The following rules were developed to help pre-college student researchers adhere to the federal regulations governing professional scientists and to protect the welfare of both animal subjects and the student researcher.

The Society for Science strongly endorses the use of non-animal research methods and encourages students to use alternatives to animal research, which must be explored and discussed in the research plan. The guiding principles for the use of animals in research include the following "Four R's":

- **Replace** vertebrate animals with invertebrates, lower life forms, tissue/cell cultures and/or computer simulations where possible.
- **Reduce** the number of animals without compromising statistical validity.
- **Refine** the experimental protocol to minimize pain or distress to the animals.
- **Respect** animals and their contribution to research. If the use of vertebrate animals is necessary, students must consider additional alternatives to reduce and refine the use of animals.

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WHAT ARE CONSIDERED VERTEBRATE ANIMALS?:

Vertebrate animals, as covered by these rules, are defined as:

1. All nonhuman vertebrates (including fish) at hatching or birth.
2. Live nonhuman vertebrate mammalian embryos or fetuses
3. Tadpoles
4. Bird and reptile eggs starting three days (72 hours) prior to hatching
5. Zebrafish past 7 days (168 hours) post-fertilization due to delayed cognitive neural development
6. Cephalopods are to be treated as vertebrate animals

NOTE: A project is not considered a vertebrate animal study if tissue is obtained from an animal that was euthanized for a purpose other than the student's project. (See Tissue & Body Fluid Rules)

PROHIBITED STUDIES:

1. Research projects which cause more than momentary or slight pain or distress to any vertebrate animals are prohibited.
2. Studies that are designed or anticipated to cause vertebrate animal death are prohibited.
3. No vertebrate animal deaths due to the experimental procedures are permitted in any group or subgroup.
4. Student researchers are prohibited from performing euthanasia.
    a. Projects conducted in a school/home/field location are prohibited from performing euthanasia for tissue removal and/or pathological analysis. (Such projects must be conducted at a Regulated Research Institution (RRI) with qualified personnel performing euthanasia.)
5. Students are prohibited from designing or participating in an experiment associated with the following types of studies on vertebrate animals:
    a. Induced toxicity studies with known toxic substances that could cause pain, distress, or death, including but not limited to alcohol, acid rain, pesticides, or heavy metals or studies with the intent to study toxic effects of a substance on a vertebrate animal.
    b. Behavioral experiments using conditioning with aversive stimuli, mother/infant separation or induced helplessness.
    c. Studies of pain.
    d. Predator/vertebrate prey experiments.
6. Students are prohibited from fishing with barbed hooks, live bait or from performing electrofishing.

RULES:

1. All vertebrate animal studies must be reviewed and approved before experimentation begins.
    a. If a study is performed in a school, home or field, the local or affiliated fair SRC serves in this approval capacity for vertebrate animal studies. Any SRC serving in this capacity must include a veterinarian or an animal care provider with training and/or experience in the species being studied.
    b. If a study is being conducted at an RRI, the Institutional Animal Care and Use Committee (IACUC) approval must be obtained. An IACUC is the institutional animal oversight review and approval body for all animal studies at an RRI.
2. The health and well-being of the vertebrate animal must be considered at all phases of the study.
3. Throughout the study, proper care must be provided at all times, including weekends, holidays, and vacation periods. Animals must be observed daily to assess their health and well-being and must be continually monitored for signs of distress.
    a. Animals must be treated kindly and cared for properly.
    b. Animals must be housed in a clean, ventilated, comfortable environment appropriate for the species.
    c. They must be given a continuous, clean (uncontaminated) water and food supply.
    d. Cages, pens and fish tanks must be cleaned frequently
4. A vertebrate animal project must be designed to ensure no more than momentary or slight pain or distress is experienced.
    a. If conducted at an RRI under an IACUC protocol, more than momentary or slight pain or distress to vertebrate animals must be relieved by IACUC-approved anesthetics, analgesics and/or tranquilizers.

5. A veterinarian must be consulted and certify experiments that involve supplemental nutrition, administration of prescription drugs and/or activities that would not be ordinarily encountered in the animal's daily life.
6. Justification is required for an experimental design that involves food or fluid restriction and must be appropriate to the species. If the restriction exceeds 18 hours, the project must be reviewed and approved by an IACUC and conducted at an RRI.
7. Research conducted in an RRI in nutritional deficiency or research involving substances or drugs of unknown effect is permitted to the point that any clinical sign of distress is noted. In the case that distress is observed, the project must be suspended and measures must be taken to correct the deficiency or drug effect. A project can only be resumed if appropriate steps are taken to correct the causal factors.
8. Any illness or unexpected weight loss must be investigated and a veterinarian consulted to receive required medical care.
    a. This investigation must be documented by the Qualified Scientist or Direct Supervisor, who must be qualified to determine the illness, or by a veterinarian.
    b. If the illness or distress is caused by the study, the experiment must be terminated immediately.
9. Because significant weight loss is one sign of stress, weight must be recorded at least weekly with 15% being the maximum permissible weight loss or growth retardation (compared to controls) of any experimental or control animal.
    a. If weighing of animals cannot be done in a fashion that is safe for both the researcher and the animal, then an explanation and approval by an SRC or IACUC needs to be included in the research plan, as well as an alternative method(s) to address signs of distress.
    b. Additionally, body conditioning scoring (BCS) systems for most species of animals utilized in research and agriculture and are an objective method for assessing the overall health status of the research subject, with or without weight loss. A BCS system should be included in the design of any study utilizing live vertebrate animals and results regularly recorded.
10. If an illness or emergency occurs, the affected animal(s) must receive proper medical or nursing care that is directed by a veterinarian.
11. A student researcher must stop experimentation if there is unexpected weight loss or death in the experimental subjects.
    a. The experiment can only be resumed if the cause of illness or death is not related to the experimental procedures and if appropriate steps are taken to eliminate the causal factors.
    b. If death is the result of the experimental procedure, the study must be terminated, and the study will not qualify for competition.
12. Students performing vertebrate animal research must satisfy US federal law as well as local, state, and country laws and regulations of the jurisdiction in which research is performed.
13. Animals may not be captured from or released into the wild without approval of authorized wildlife or other regulatory officials. All appropriate methods and precautions must be used to decrease stress.
14. 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. The use of electrofishing is permissible only if conducted by a trained supervisor.
15. Vertebrate animal projects may be conducted at a home, school, farm, ranch, in the field, etc. including:
    - 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:
    a. The research involves only agricultural, behavioral, observational or supplemental nutritional studies on animals. AND
    b. The research involves only non-invasive and nonintrusive methods that do not negatively affect an animal's health or well-being.
16. Some protocols permitted in a Regulated Research Institution are not permitted for participation in ISEF; adherence to RRI rules is necessary but may not be sufficient.

AFTER EXPERIMENTATION/ EUTHANASIA

1. Projects conducted at school/home/field site must plan for the final disposition of the animals in the study.
    a. The final disposition of the animals must be conducted in a responsible and ethical manner.
    b. Euthanasia for tissue removal and/or pathological analysis is not permitted for a project conducted in a school/home/field site.
    c. Livestock or fish raised for food using standard agricultural/ aquacultural production practices may be euthanized by a qualified adult for carcass evaluation.
2. Euthanasia at the end of experimentation for tissue removal and/or pathological analysis is permitted at an RRI by qualified personnel, not by the student researcher. All methods of euthanasia must adhere to current American Veterinary Medical Association (AVMA) Guidelines.

DEATH VERIFICATION:

1. Any unexpected death that occurs must be investigated by a veterinarian, the Qualified Scientist or the Direct Supervisor **who is qualified to determine if the cause of death was incidental or due to the experimental procedures.**
    a. The project must be suspended until the cause is determined and then the results must be documented in writing.
    b. If death was the result of the experimental procedure, the study must be terminated, and the study will not qualify for competition.

DOCUMENTATION AND APPROVAL

1. Student researchers must have a Research Plan that includes all of the standard elements as well as the following areas specific to vertebrate animal research:
    a. Justification why animals must be use.
        • including the reasons for the choice of species,
        • the source of animals and the number of animals to be used;
        • Description, explanation, or identification of alternatives to animal use that were considered with reasons these alternatives were unacceptable;
        • explanation of the potential impact or contribution this research may have on the broad fields of biology or medicine.
    b. Description of how the animals will be used.
        • Include methods and procedures, such as experimental design and data analysis;
        • description of the procedures that will minimize the potential for discomfort, distress, pain and injury to the animals during the course of experimentation;
        • identification of the animals proposed for use, to include:
            » species
            » strain
            » sex
            » age
            » weight
            » source
            » number of animals
2. All vertebrate animal studies must be reviewed and approved before experimentation begins.
    a. The local or affiliated fair Scientific Review Committee serves in this capacity for vertebrate animal studies performed in a school, home or field. Any SRC serving in this capacity must include a veterinarian or an animal care provider with training and/or experience in the species being studied.
    b. The local or affiliated fair SRC must determine if a veterinarian's certification of the research and animal husbandry plan is required. This certification, as well as SRC approval, is required before experimentation and is documented on Vertebrate Animal Form 5A. A veterinarian must certify experiments that involve supplemental nutrition, administration of prescription drugs and/or activities that would not be ordinarily encountered in the animal's daily life.
    c. An Institutional Animal Care and Use Committee, known as an IACUC, is the institutional animal oversight review and approval body for all animal studies at a Regulated Research Institution.
    d. When working at an RRI, the IACUC or the comparable animal oversight committee must approve all student research projects before experimentation begins. Such research projects must be conducted under the responsibility of a principal investigator. The local and affiliated fair SRCs must also review the project to certify that the research project complies with ISEF Rules. This local and regional SRC review should occur before experimentation begins, if possible.
    e. A Qualified Scientist or Direct Supervisor must directly supervise all research involving vertebrate animals, except for observational studies under the exempt guidelines below.
    f. After initial SRC approval, a student with any proposed changes in the Research Plan/Project Summary of the project must repeat the approval process before laboratory experimentation/data collection resumes.
    g. The following forms are required:
        » Checklist for Adult Sponsor (1),
        » Student Checklist (1A),
        » Research Plan/Project Summary,
        » Approval Form (1B) » Vertebrate Animal Form (5A) if conducted at home/school/field OR Vertebrate Animal Form (5B) if conducted at an RRI
        » Qualified Scientist Form (2), when applicable
        » Regulated Research Institution Form (1C), when applicable

EXEMPT STUDIES (DO NOT REQUIRE SRC PREAPPROVAL)

1. Studies involving behavioral observations of animals are exempt from prior SRC review if ALL of the following apply:
    a. There is no interaction with the animals being observed,
    b. There is no manipulation of the animal environment in any way, and
    c. The study meets all federal and state agriculture, fish, game and wildlife laws and regulations.

Sources of information: Vertebrate Animals

Animal Care and Use

1) Laboratory Animals, Institute of Laboratory Animal Research (ILAR), Commission on Life Sciences, National Research
http://dels.nas.edu/ilar/institute-for-laboratory-animal-research

2) Guide for the Care and Use of Laboratory Animals, 8th Edition (2011)
http://grants.nih.gov/grants/olaw/Guide-for-the-Care-and-Use-of-Laboratory-Animals.pdf
www.nap.edu/catalog.php?record_id=12910

3) Guidelines for the Care and Use of Mammals in Neuroscience and Behavioral Research (2003), Institute for Laboratory Animal Research (ILAR).
dels.nas.edu/report/guidelines-carey/10732
To order these ILAR publications contact:
National Academies Press
500 Fifth Street, NW
Washington, DC 20055
phone: 888-624-8373 or 202-334-3313
fax: 202-334-2451; www.nap.edu

4) Federal Animal Welfare Act (AWA)
7 U.S.C. 2131-2157
Subchapter A - Animal Welfare (Parts I, II, III)
www.nal.usda.gov/awic/animal-welfare-act
Above document is available from:
USDA/APHIS/AC
4700 River Road, Unit 84
Riverdale, MD 20737-1234
email: ace@aphis.usda.gov
Tel: 301-734-7833
Fax: 301-734-4978'
http://awic.nal.usda.gov

5) *Guide for the Care and Use of Agricultural Animals in Agricultural Research and Teaching (Agri-Guide)*

Association for Assessment and Accreditation of Laboratory Animal Care International (AAALAC International) https://www.aaalac.org/ https://www.aaalac.org/about/Ag_Guide_3rd_ed.pdf

6) Guidelines for the Use of Fish in Research (2004), American Fisheries Society.
www.fisheries.org
www.fisheries.org/afs/docs/policy_16.pdf

7) Euthanasia Guidelines
AVMA Guidelines on Euthanasia (June 2007)
American Veterinary Medical Association.
www.avma.org/KB/Policies/Documents/euthanasia.pdf

Alternative Research and Animal Welfare

1) The National Library of Medicine provides computer searches through MEDLINE:
Reference & Customer Services
National Library of Medicine
8600 Rockville Pike
Bethesda, MD 20894
888-FIND-NLM or 888-346-3656 301-594-5983; email: info@ncbi.nlm.nig.gov
www.nlm.nih.gov
www.ncbi.nlm.nih.gov/sites/entrez

2) National Agriculture Library (NAL) provides reference service for materials that document a) Alternative Procedures to Animal Use and b) Animal Welfare.
Animal Welfare Information Center
National Agriculture Library
10301 Baltimore Avenue, Room 410
Beltsville, MD 20705-2351
phone: 301-504-6212, fax: 301-504-7125
email: awic@ars.usda.gov
www.nal.usda.gov/awic

3) Institute of Laboratory Animal Resources (ILAR) provides a variety of information on animal sources, housing and handling standards, and alternatives to animal use through annotated bibliographies published quarterly in ILAR Journal.
ILAR
The Keck Center of the National Academies
500 Fifth Street, NW, Keck 687
Washington, DC 20001
phone: 202-334-2590, fax: 202-334-1687 email: ILAR@nas.edu
http://dels.nas.edu/ilar

4) Quarterly bibliographies of Alternatives to the Use of Live Vertebrates in Biomedical Research and Testing may be obtained from:
Specialized Information Services
NLM/NIH
2 Democracy Plaza, Suite 510
6707 Democracy Blvd., MSC 5467 Bethesda, MD 20892-5467
phone: 301-496-1131; Fax: 301-480-3537
Toll Free: 888-FIND NLM or 888-346-3656
email: tehip@teh.nlm.nih.gov
www.sis.nlm.nih.gov;
http://toxnet.nlm.nih.gov/altbib.html

5) John's Hopkins Center for Alternatives to Animal Testing (CAAT) has worked with scientists since 1981 to find new methods to replace the use of laboratory animals in experiments, reduce the number of animals tested, and refine necessary tests to eliminate pain and distress.
email: caat@jhsph.edu
http://caat.jhsph.edu/

6) Quality Assurance Manuals (for appropriate species) Such as:

Poultry: https://www.bordbia.ie/industry/farmers/quality/PoultrySchemeStandards/Poultry%20Producer.pdf

Beef: https://www.bqa.org/Media/BQA/Docs/nationalmanual. pdf

Pork: http://www.pork.org/

3. Potentially Hazardous Biological Agents

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

Students are permitted to do research projects with potentially hazardous biological agents meeting the conditions and rules described below which were designed to protect students and to ensure adherence to federal and international biosafety regulations and guidelines.

PROHIBITED STUDIES:

1. Experimentation involving the culturing of potentially hazardous biological agents, even BSL-1 organisms and *C. elegans*, is prohibited in a home environment.
    a. However, specimens may be collected at home as long as they are immediately transported to a laboratory with the BSL containment determined by the affiliated fair SRC.
2. Students are prohibited from designing or participating in any research involving biosafety levels above BSL-2. (This includes BSL-2+, BSL-3 and BSL-4.)
3. Any study involving the collection and examination of body fluids that may contain biological agents belonging to a biosafety level over 2 is prohibited. (Please see Tissue & Body Fluid Rules)
4. Students are prohibited from the insertion of antibiotic resistance traits or selection of organisms expressing traits that may affect the ability to provide effective treatment of infections acquired by humans, animals, or plants. a. Students are prohibited from designing or selecting for multiple drug resistant organisms (MDROs) to investigate the pathology, development, or treatment of antibiotic- resistant infections.
5. All studies involving the use of prions or prion-like proteins are prohibited. This includes studies working with amyloid-b (Ab), tau, a-synuclein, transactive response DNA-binding protein of 43 kDa, and amyloid fibrils.
6. Propagation of recombinants containing DNA coding for human, plant or animal toxins (including viruses) is prohibited.
7. Introduction or disposal of non-native, genetically altered, and/or invasive species (e.g. insects or other invertebrates, plants, vertebrates), pathogens, toxic chemicals or foreign substances into the environment is prohibited. Students and adult sponsors should reference their local, state and national regulations and quarantine lists.

RULES

1. Prior review and approval is required for the use of potentially hazardous microorganisms (including bacteria, viruses, viroids, rickettsia, fungi, cyanobacteria, and parasites) and recombinant DNA (rDNA) technologies.
2. Research determined to be at Biosafety Level 1 (BSL1) must be conducted in a BSL-1 or higher laboratory. The research must be supervised by a trained Direct Supervisor or a Qualified Scientist. The student must be properly trained in standard microbiological practices.
3. Research determined to be a Biosafety Level 2 (BSL2) must be conducted in a laboratory rated BSL-2 or above and follow BSL-2 safety conditions throughout the study. (Commonly limited to a Regulated Research Institution (RRI). The research must be reviewed and approved by the Institutional Biosafety Committee (IBC) if the RRI requires the review. For a high school BSL-2 laboratory, the SRC must review and approve. The research must be supervised by a Qualified Scientist.
4. Laboratory studies involving the culturing of clinically significant multidrug resistant organisms (MDROs) must have a written justification for usage and be conducted at an RRI laboratory with a minimum of BSL-2 containment and documented IBC review and approval.
    a. Representative examples include, but are not limited to the following known agents: MRSA (Methicillin-Resistant *Staphylococcus aureus*), VISA/VRSA (Vancomycin Intermediate or Resistant *Staphylococcus aureus*), VRE (VancomycinResistant Enterococci), CRE (Carbapenem Resistant Enterobacteriacae), ESBLs (Extended Spectrum Beta-Lactamase producing gram negative organisms), and fungi (yeasts or molds) with known resistance to antifungal agents.
    b. Extreme caution must be exercised when selecting and sub-culturing antibiotic-resistant organisms. Studies using such organisms, including BSL-1 organisms that may have originally been exempt from prior SRC approval, require at least BSL-2 containment.
    c. Insertion of antibiotic resistance markers for the clonal selection of bioengineered organisms is permitted, with the exceptions outlined in prohibited studies item #4.
5. The culturing of human or animal waste, including sewage sludge, is considered a BSL-2 study.
6. Naturally-occurring plant pathogens may be studied (not cultured) at home, but may not be introduced into a home/ garden environment.
7. Projects involving water samples collected from active Harmful Algal Blooms are considered BSL-2 studies.
8. Insect and arthropod vector-borne pathogens such as Malaria, Lyme, etc. are considered BSL-2 studies.
9. All local, state and national laws and permit requirements must be followed regarding the transport and use of microorganisms such as, but not limited to citrus greening or tobacco mosaic, etc.

10. All potentially hazardous biological agents must be properly disposed of at the end of experimentation in accordance with their biosafety 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, biosafety pick-up and other manufacturer recommendations are acceptable.

PROJECTS INVOLVING UNKNOWN MICROORGANISMS

Studies involving unknown microorganisms must adhere to the following rules:

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 sterile non-breakable container) and sealed.
    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 Direct Supervisor.
2. If a culture container with unknown microorganisms is opened for any purpose, (except for disinfection/ disposal), it must be treated as a BSL-2 study and involve BSL-2 laboratory precautions.

PROJECTS INVOLVING RECOMBINANT DNA (RDNA) TECHNOLOGIES

1. All rDNA technology studies involving BSL-1 organisms and BSL-1 host vector systems, including commercially available kits, must be conducted in at least a BSL1 laboratory under the supervision of a Qualified Scientist or Direct Supervisor and must be approved by the SRC prior to experimentation. Examples include cloning of DNA in *E. coli* K–12, *S. cerevesiae*, and *B. subtilis* host-vector systems.
    a. 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.
    b. All rDNA technology studies involving BSL-2 organisms and/or BSL-2 host vector systems must be conducted in an RRI and approved by the IBC prior to experimentation, where applicable.
    c. All genome editing studies that include alteration of germline cells, insertion of gene drives, use of rapid trait development systems (RTDS®), etc., should be categorized as a BSL-2 study and must be conducted at an RRI and approved by the IBC from the institution. Qualified scientists are expected to ensure that student research protocols address appropriate intrinsic and extrinsic containment precautions.

DOCUMENTATION AND APPROVAL

1. The student and all of the adults involved in a research project must conduct and document a risk assessment on Form (6A) to define the potential level of harm, injury or disease to plants, animals and humans that may occur when working with biological agents. The risk assessment determines a biosafety level which in turn determines if the project can proceed, and if so, the proposed laboratory facility is properly equipped and all personnel are trained and appropriate supervision is planned.:
    a. Give source of the organism and describe BSL assessment process and BSL determination.
    b. Detail safety precautions and discuss methods of disposal.
2. Prior review and approval is required for the use of potentially hazardous microorganisms (including bacteria, viruses, viroids, rickettsia, fungi, and parasites) and recombinant DNA (rDNA) technologies.
    a. An affiliated fair SRC, an IBC or an IACUC must approve all research before experimentation begins.
    b. The initial risk assessment determined by the student researcher and adults supervising the project must be confirmed by the SRC, IBC or IACUC.
3. Any proposed changes in the Research Plan/Project Summary by the student after initial local or affiliated fair SRC approval must undergo subsequent SRC, IBC or IACUC review and approval before such changes are made and before experimentation resumes.
4. The following forms are required:
    » Checklist for Adult Sponsor (1)
    » Student Checklist (1A)
    » Research Plan/Project Summary
    » Approval Form (1B)
    » Regulated Research Institution Form (1C) — when applicable
    » Qualified Scientist (2), when applicable
    » Risk Assessment (3), when applicable
    » PHBA Risk Assessment Form (6A), when applicable
    » The BSL-2 Checklist when a BSL-2 facility is used that is not at a Regulated Research Institution.

EXEMPT STUDIES (NO SRC PRE-APPROVAL REQUIRED)

The following types of studies are exempt from prior SRC review, but require a Risk Assessment Form 3:

- Studies involving protists and archaea
- Research using manure for composting, fuel production, or other non-culturing experiment
- Commercially available color change coliform detection 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 in which the device is sealed during experimentation and disposed of properly at the conclusion of the study
• Studies involving fermentation of baker's yeast and brewer's yeast, except in rDNA studies
• Studies involving *Lactobacillus, Bacillus thuringiensis*, nitrogen-fixing, oil-eating, and algae-eating bacteria introduced into their natural environment (not exempt if cultured in a petri dish environment)
• Studies involving water or soil microbes not concentrated in media conducive to their microbial growth
• Studies of mold growth on food items if the experiment is terminated at the first evidence of mold
• Studies of slime molds and edible mushrooms
• Studies involving *E. coli* OP-50 and other strains of *E. coli* that are used solely as a food source for *C. elegans* and are performed at school and are not subject to additional rules for recombinant DNA studies or use of antibiotic-resistant organisms.
• Studies involving *E. coli* K-12 that are performed at school and are not subject to additional rules for recombinant DNA studies or use of antibiotic resistant organisms.

TISSUE & BODY FLUID RULES

Fresh/frozen tissue (including primary vertebrate cell lines, human and other primate established cell lines and tissue cultures), blood, blood products and body fluids.
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 and must receive the same considerations as potentially hazardous biological agents.

PROHIBITED STUDIES

1. Any study involving the collection and examination of body fluids, including blood, that may contain biological agents belonging to BSL-2+, BSL-3, BSL-4 is prohibited.

RULES

1. Research involving human and/or non-human primate established cell lines and tissue culture collections (e.g., obtained from the American Type Culture Collection) must be considered a BSL-1 or BSL-2 level organism as indicated by source information and treated accordingly.
2. If tissues are obtained from an animal that was euthanized for a purpose other than the student's project, it may be considered a tissue study.
    a. Use of tissues obtained from research conducted at a Regulated Research Institution (RRI) requires a copy of the Institutional Animal Care and Use Committee (IACUC) certification with the name of the research institution, the title of the study, the IACUC approval number and date of IACUC approval.
    b. Use of tissues obtained from agricultural/ aquacultural studies require prior SRC approval.
3. If the animal was euthanized solely for the student's project, the study must be considered a vertebrate animal project and is subject to the vertebrate animal rules. (See vertebrate animal rules.)
4. The collection and examination of fresh/frozen tissues or body fluids or meat and meat by-products obtained from food stores, restaurants, or packing houses must be considered biosafety Level 1 studies and must be conducted in a BSL-1 laboratory or higher.
5. The collection and examination of fresh/frozen tissues or body fluids or meat and meat by-products NOT obtained from food stores, restaurants, or packing houses may contain microorganisms. Because of the increased risk from unknown potentially hazardous agents, these studies must be considered biosafety level 2 studies conducted in a BSL-2 laboratory under the supervision of a Qualified Scientist.
6. Human breast milk of unknown origin, unless certified free of HIV and Hepatitis C, and domestic unpasteurized animal milk are considered BSL-2.
7. All studies involving human or wild animal blood or blood products, except those that only involve blood from student researcher(s) should be at a minimum a BSL-2 study done under the supervision of a Qualified Scientist. Studies involving domestic animal blood may be considered a BSL-1 level study. All blood must be handled in accordance with standards and guidelines set forth in the OSHA, 29CFR, Subpart Z. Any tissue or instruments with the potential of containing blood-borne pathogens (e.g. blood, blood products, tissues that release blood when compressed, blood contaminated instruments) must be properly disposed of after experimentation.
8. Studies of human body fluids, where the sample can be identified with a specific person, must have IRB review and approval, and informed consent.
9. A project involving a student researcher using their own body fluids (if not cultured)
    a. must receive prior SRC review and approval prior to experimentation
    b. can be considered a BSL-1 study
    c. may be conducted in a home setting
    d. must have Institutional Review Board (IRB) review if the body fluid is serving as a measure of an effect of an experimental procedure on the student researcher (e.g. student manipulates diet and takes a blood or urine sample). An example of a project not needing IRB review would be collecting urine to serve as a deer repellent.

10. Studies involving embryonic human stem cells must be conducted in an RRI and reviewed and approved by the ESCRO (Embryonic Stem Cell Research Oversight) Committee.

DOCUMENTATION AND APPROVAL

1. Student researchers must have a Research Plan that includes all of the standard elements as well as the following areas specific to tissue research:
    a. Give source of the organism and describe BSL assessment process and BSL determination.
    b. Detail safety precautions and discuss methods of disposal.
2. The source and/or catalog number of the cultures must be identified in the Research Plan/Project Summary, and on forms 6A and 6B, even if the project is exempt from IRB approval. If catalog number is unavailable, student can provide a receipt and/or letter from mentor regarding the origin of the items.
    a. If the tissue is obtained from a private/noncommercial source (public or private laboratory, museum, etc.), documentation from the supplier must be uploaded in the application, including IACUC approvals for the original study. This includes samples from blood banks or human breast milk.
    b. If obtained from mentor's study or another lab's study, upload original study's IACUC approval OR reference to the original study's publication.
3. Prior review and approval is required for the use of human or vertebrate fresh/frozen tissues, blood, or body fluids.
    a. An affiliated fair SRC, an IBC or an IACUC must approve all research before experimentation begins.
    b. The initial risk assessment determined by the student researcher and adults supervising the project must be confirmed by the SRC, IACUC, or Institutional Biosafety Committee (IBC).
4. Any proposed changes in the Research Plan/Project Summary by the student after initial local or affiliated fair SRC approval must undergo subsequent SRC or IBC review and approval before such changes are made and before experimentation resumes.
5. The following forms are required:
    » Checklist for Adult Sponsor (1)
    » Student Checklist (1A)
    » Research Plan/Project Summary
    » Approval Form (1B)
    » Regulated Research Institution Form (1C) — when applicable
    » Qualified Scientist (2), when applicable
    » Risk Assessment (3), when applicable
    » PHBA Risk Assessment Form (6A)
    » Human and Vertebrate Animal Tissue Form (6B)
    » The BSL-2 Checklist when a BSL-2 facility is used that is not at a Regulated Research Institution.

EXEMPT TISSUES (NO SRC PRE-APPROVAL REQUIRED)

1. The following types of tissue do not need to be treated as potentially hazardous biological agents:
    a. Plant tissue (except those known to be toxic or hazardous)
    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/Project Summary and on forms 6A and 6B
    c. Human capillary/blood collection (i.e. finger stick) of the student researcher to themself; blood collection from any other human participants must be reviewed and approved by an IRB
    d. Fresh or frozen meat, meat by-products obtained from food stores, restaurants, or packing houses and eggs or pasteurized milk
    e. Hair, hooves, nails and feathers
    f. Teeth that have been sterilized to kill any bloodborne pathogen that may be present
    g. Fossilized tissue or archeological specimens.
2. Projects utilizing only data or images are exempt from IACUC pre-approval ONLY if the originating study is published in a peer-reviewed journal or the data is available in a publicly available database. In this case, the student must provide a reference to the original study OR link to the database.
3. If the data or images were obtained from another scientist (mentor or not a mentor) or source AND the research is not yet published (not publicly available), then IACUC approval of the original study must be provided by the ISEF participant.

Potentially Hazardous Biological Agents Risk Assessment

Use this information to complete PHBA Risk Assessment Form 6A

Risk assessment defines the potential level of harm, injury or disease to plants, animals and humans that may occur when working with biological agents. The end result of a risk assessment is the assignment of a biosafety level which then determines the laboratory facilities, equipment, training, and supervision required.

Risk assessment involves:

- 1. Assignment of the biological agent to a risk group
- 2. Studies involving a known microorganism must begin with an initial assignment of the microorganism to a biosafety level risk group based on information available through a literature search.
- 3. The study of unknown microorganisms and the use of fresh tissues relies on the expertise of the supervising adult(s).
- 4. Determination of the level of biological containment available to the student researcher to conduct the experimentation. (See "Levels of Biological Containment" for details.)
- 5. Assessment of the experience and expertise of the adult(s) supervising the student.
- 6. Assignment of a biosafety level for the study based on risk group of biological agent, level of biological containment available and the expertise of the Qualified Scientist or Designated Supervisor who will be supervising the project.
- 7. Documentation of review and approval of study prior to experimentation:
- a. If a study is conducted at a non-regulated site (e.g. school), the SRC reviews the Research Plan/Project Summary.
- b. If the study was conducted at a Regulated Research Institution, and was approved by the appropriate institutional board (e.g. IBC, IACUC), the SRC reviews the institutional forms provided and documents SRC approval (Form (6A)).
- c. If a PHBA study was conducted at a Regulated Research Institution but the institution does not require review for this type of study, the SRC must review the study and document approval on Form 6A that the student received appropriate training and the project complies with ISEF rules.

Classification of Biological Agents

Risk Groups

Biological agents, plant or animal, are classified according to biosafety level risk groups. These classifications presume ordinary circumstances in the research laboratory, or growth of agents in small volumes for diagnostic and experimental purposes.

BSL-1 risk group contains biological agents that pose low risk to personnel and the environment. These agents are highly unlikely to cause disease in healthy laboratory workers, animals or plants. The agents require Biosafety Level 1 containment. Examples of BSL-1 organisms are: *Agrobacterium tumifaciens*, *Micrococcus leuteus*, *Neurospora crassa*, *Bacillus subtilis*.

BSL-2 risk group contains biological agents that pose moderate risk to personnel and the environment. If exposure occurs in a laboratory situation, the risk of spread is limited and it rarely would cause infection that would lead to serious disease. Effective treatment and preventive measures are available in the event that an infection occurs. The agents require Biosafety Level 2 containment. Examples of BSL-2 organisms are: Mycobacterium, *Streptococcus pneumonia*, *Salmonella choleraesuis*.

BSL-3 risk group contains biological agents that usually cause serious disease (human, animal or plant) or that can result in serious economic consequences. Projects in the BSL-3 group are prohibited.

BSL-4 risk group contains biological agents that usually produce very serious disease (human, animal or plant) that is often untreatable. Projects in the BSL-4 group are prohibited.

Levels of Biological Containment

There are four levels of biological containment (Biosafety Level 1–4). Each level has guidelines for laboratory facilities, safety equipment and laboratory practices and techniques.

BSL-1 containment is normally found in water-testing laboratories, in high schools, and in colleges teaching introductory microbiology classes. Work is done on an open bench or in an appropriate biosafety hood. Standard microbiological practices are used when working in the laboratory. Decontamination can be achieved by treating with chemical disinfectants or by steam autoclaving. Lab coats and gloves are required. The laboratory work is supervised by an individual with general training in microbiology or a related science.

BSL-2 containment is designed to maximize safety when working with agents of moderate risk to humans and the environment. Access to the laboratory is restricted. Biological safety cabinets (Class 2, type A, BSC) must be available. An autoclave should be readily available for decontaminating waste materials. Lab coats and gloves are required; eye protection and face shields must also be worn as needed. The laboratory work must be supervised by a scientist who understands the risk associated with working with the agents involved.

BSL-3 containment is required for infectious agents that may cause serious or potentially lethal diseases as a result of exposure by inhalation. Projects in the BSL-3 group are prohibited.

BSL-4 containment is required for dangerous/exotic agents that pose high risk of life-threatening disease. Projects in the BSL-4 group are prohibited.

Sources: Potentially Hazardous Biological Agents

1) American Biological Safety Association: ABSA Risk Group Classification – list of organisms
www.absa.org
2) American Type Culture Collection (ATCC)
www.atcc.org
3) Bergey's Manual of Systematic Bacteriology website – follow the links for resources and microbial databases for a collection of international websites of microorganisms and cell cultures: www.bergeys.org/resources.html
4) Biosafety in Microbiological and Biomedical Laboratories (BMBL) - 4th Edition. Published by CDC-NIH,
www.cdc.gov/biosafety/publications/bmbl5/BMBL.pdf
5) World Health Organization Laboratory Safety Manual
www.who.int/diagnostics_laboratory/guidance/en/
6) Canada – Agency of Public Health – list of non-pathogenic organisms
https://www.canada.ca/en/public-health/services/laboratory- biosafety-biosecurity/pathogen-safety-data-sheets-risk- assessment.html
7) American Society for Microbiology
https://www.asm.org/division/w/web-sites.htm

8) Microbiology Society Charles Darwin House 12 Roger Street London WC1N 2JU
UK education@microbiologysociety.org http://microbiologyonline.org

9) NIH Guidelines for Research Involving Recombinant DNA Molecules. Published by National Institutes of Health.
https://osp.od.nih.gov/wp-content/uploads/2013/06/NIH_ Guidelines.pdf
10) OSHA – Occupational Health and Safety Administration
www.osha.gov

4. Hazardous Chemicals, Activities or Devices

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

The following rules apply to projects using hazardous chemicals, devices and activities. These include substances and devices that are regulated by local, state, country, or international law. Hazardous activities are those that involve a level of risk above and beyond that encountered in the student's everyday life. The student researcher must minimize the impact of an experiment on the environment.

PROHIBITED STUDIES

1. A study using prescription drugs is prohibited when the prescription is being used outside of the purpose for which it was prescribed.
2. Students are prohibited from conducting experiments where consumable ethyl alcohol is produced by distillation.
3. Any study using DEA controlled substances is prohibited in a school or home setting.
4. Any study using > 25 kvolts of radiation is prohibited in a school or home setting.
5. All radiation studies may not exceed the dose limits set by the Nuclear Regulatory Commission of 0.5 mrem/hr or 100 mrem/year of exposure.
6. Underage researchers are prohibited from the following:
    a. Purchasing alcohol, tobacco, and vape products
    b. Purchasing firearms or ammunition, including black powder
    c. Purchasing explosives
7. All projects using chemicals with a GHS safety rating of 1, 2, or 3, or NFPA safety rating of 3 or 4, must be conducted in a school or laboratory setting.

RULES

1. The student researcher must conduct a risk assessment in collaboration with a Direct Supervisor or Qualified Scientist prior to experimentation. The research must be supervised as appropriate for the hazardous substance, activity or device being used.
2. Students are required to meet all standards and rules imposed by ISEF, school, local, and/or regional fair(s).
3. Student researchers must acquire and use regulated substances in accordance with all local, state, U.S. federal and country laws. This includes:
    a. Regulations regarding DEA-controlled substances,
    b. FDA and state laws regarding prescription drugs,
    c. TTB and state laws regarding alcohol and tobacco,
    d. ATF and state laws regarding firearms and explosives and
    e. FAA and state laws regarding drones.
    For further information or classification for these laws and regulations, contact the appropriate regulatory agencies.
4. For all chemicals, devices or activities requiring a federal and/ or state permit, the student/supervisor must obtain the permit prior to the onset of experimentation. All transportation and acquisition of materials must comply with all Federal and State laws and regulations.
5. Projects using chemicals with a Globally Harmonized System of Classification and Labelling of Chemicals (GHS) safety rating of 1, 2 or 3 or National Fire Protection Association (NFPA) safety rating of 3 or 4 must be conducted in a school or laboratory setting. Projects conducted with chemicals outside these ratings may be conducted in a home setting under the following conditions:
    a. Projects in a home setting must follow standard lab practices for chemical handling, safety, ventilation, and specific disposal procedures used as outlined in the Safety Data Sheets (SDS).
    b. Any cookware, utensils, and/or equipment used during the experimentation cannot be reused for food preparation.
    c. Be conducted with a Direct Supervisor with proper training and knowledge of the chemicals being used.
6. Disposal procedures shall be described in sufficient detail to ensure compliance with EPA Guidelines as outlined in the appropriate Safety Data Sheets. Examples include minimal quantities of chemicals that will require subsequent disposal; ensuring that all disposal is done in an environmentally safe manner. Proper chemical, sharps and other hazardous materials disposal must follow local, state, and federal guidelines.

DEA-CONTROLLED SUBSTANCES

The U.S. Drug Enforcement Administration (DEA) regulates chemicals that can be diverted from their intended use to make illegal drugs.

1. All studies using DEA-controlled substances must be supervised by a Qualified Scientist at a Regulated Research Institution (RRI) and must be conducted at an RRI who is licensed by the DEA (or other international regulatory body) for use of the controlled substance.
2. All studies using DEA Schedule 1 substances (including marijuana) must have the research protocol approved by DEA before research begins. Schedule 2, 3 and 4 substances do not require protocol approval by DEA.

PRESCRIPTION DRUGS

In the United States, the Food and Drug Administration (FDA) tightly regulates the issuance of prescription drugs including non-controlled medications. It is unlawful to use a prescription for persons or purposes outside of the original intent of the prescription or for the person it was originally prescribed for. All applicable federal, state, and country laws must be followed.

1. A study involving prescription drugs must obtain the prescription drug through the authority of a practitioner or researcher that has obtained the noncontrolled medication with appropriate approvals or be using a prescription drug that is a research or education research-grade product and therefore not for human consumption.
2. Research involving prescription drugs being administered to vertebrate animals, may only be done under a veterinarian's supervision and with prescriptions provided for this specified purpose.

ALCOHOL AND TOBACCO

The U.S. Alcohol and Tobacco Tax and Trade Bureau (TTB) regulates the production of alcohol and distribution of alcohol and tobacco products. Many such products are restricted by age for purchase, possession and consumption.

1. Fermentation studies in which minute quantities of ethyl alcohol are produced are permitted.
2. The Direct Supervisor is responsible for the acquisition, usage and appropriate disposal of the alcohol, tobacco, or vape products used in the study.
3. Production of wine or beer by adults is allowable in the home and must meet TTB home production regulations. Students are allowed to design and conduct a research project, under direct parental supervision, involving the legal production of the wine or beer.
4. Students may distill alcohol for fuel or other nonconsumable products, but the work must be conducted at school or a Regulated Research Institution and follow all local and country laws.

FIREARMS AND EXPLOSIVES

The U.S. Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF), along with state agencies, regulates the purchase and use of firearms and explosives. Explosives include, but are not limited to, dynamite, black powder, pellet powder, detonators, and igniters. The purchase of a firearm by a minor is generally unlawful. The use of a firearm, without proper state certification, is illegal. Students should check the training and certification requirements of individual states and countries.

1. Projects involving firearms and explosives are allowable when conducted with the direct supervision of a Direct Supervisor and when in compliance with all federal, state and local laws. Any use of a firearm must be conducted with the proper state certification and training.
2. A fully assembled rocket motor, reload kit or propellant modules containing more than 62.5 grams of propellant are subject to the permitting, storage, transportation, and other requirements of federal explosive laws and regulations.
3. Potato guns and paintball guns are not considered firearms unless they are intended to be used as weapons. However, they must be treated as hazardous devices.

REGULATED DRONES

1. Projects involving unmanned aircraft systems (UAS)/ drones must follow all state, federal and country laws. See the Federal Aviation Administration (FAA) for more details (https://www.faa.gov/uas/).
2. Current U.S. law requires all forms of drones to be registered with the FAA.

RADIATION

Projects involving radionuclides (radioisotopes) and X-rays must involve a careful examination of the risks associated with the study and appropriate safety precautions must be taken.

1. If the voltage needed in the study is <10 kvolts, a risk assessment must be conducted. The study may be done at home or school, and SRC preapproval is not required.
2. A study using 10-25 kvolts must have a risk assessment conducted and must be preapproved by the SRC to assess safety. Such a study must be conducted in a metal-lined chamber using a camera only, not direct view through glass. A dosimeter or radiation survey meter is required to measure radiation exposure.
3. All studies using >25 kvolts must be conducted at an institution with a Licensed Radiation Program and must be preapproved by the Institutions' Radiation Safety Officer or the Committee which oversees the use of ionizing radiation to ensure compliance with state and federal regulations.

DOCUMENTATION AND APPROVAL

1. Student researchers must have a Research Plan that includes all of the standard elements as well as a thorough risk assessment that discusses:
    - process,
    - supervision,
    - usage,
    - safety precautions and
    - methods of disposal
2. The student researcher must conduct a risk assessment in collaboration with a Direct Supervisor or Qualified Scientist prior to experimentation. The result of this review is also documented on Risk Assessment Form 3.
3. Any permits and/or licenses collected as a requirement of the project must be included with the project paperwork and must be available for review by adults supervising the project and the local, affiliated, and ISEF SRCs in their review prior to competition.
4. The following forms are required:
    - » Checklist for Adult Sponsor (1)

» Student Checklist (1A)
» Research Plan/Project Summary
» Approval Form (1B)
» Regulated Research Institution Form (1C), when applicable
» Qualified Scientist (2), when applicable
» Risk Assessment (3)

The International Rules & Guidelines use several terms to describe individuals involved in the research and the review committees that support the pre-approval and competition review to ensure the safety of the student researchers and all involved in the research.

Environmentally Responsible Chemistry

The mission of environmentally responsible (green) chemistry is to avoid the use or production of hazardous substances during chemical process. The principles of green chemistry are described on the EPA website in the Sources of Information section. Whenever possible the following principles should be incorporated into the research plan.

- Waste prevention
- Use of the safest possible chemicals and products
- Design of the least possible hazardous chemical syntheses
- Use renewable materials
- Use of catalysts in order to minimize chemical usage
- Use of solvents and reaction conditions that are safe as possible
- Maximization of energy efficiency
- Minimization of accident potential and avoiding the use of reactive substances

Sources: Hazardous Chemicals, Activities or Devices

General Lab/Chemical Safety
1) Safety in Academic Chemistry Laboratories, Volumes 1 and 2, 2003. Washington, DC: American Chemical Society.
Order from (first copy free of charge):
American Chemical Society
Publications Support Services
1155 16th Street, NW
Washington, DC 20036
phone: 202-872-4000 or 800-227-5558
email: help@acs.org,
www.acs.org/education
2) Environmental Protection Agency (EPA) website for green chemistry
www.epa.gov/greenchemistry
3) Safety and Data Sheets (SDS)
http://www.flinnsci.com/msds-search.aspx/
A directory of SDS sheets from Flinn Scientific Inc. that includes a ranking of hazard level and disposal methods
www.ilpi.com/msds/index.html - A listing of numerous sites that have free downloads of SDS sheets
4) Pesticides
National Pesticide Information Center
http://npic.orst.edu/ingred/products.html
Describes the various types of pesticides and the legal requirements for labelling. Provides links and phone numbers to get additional information.
Environmental Protection Agency
http://iaspub.epa.gov/apex/pesticides/f?p=PPLS:1
A database of product labels. Enter the product name or company name to view the approved label information of pesticides which are registered with the agency.
5) DEA Controlled Substances
Drug Enforcement Agency website:
www.justice.gov/dea/index.htm
Controlled Substance Schedules – a list of controlled substances : www.deadiversion.usdoj.gov/schedules/

6) Alcohol, Tobacco Firearms and Explosives
Alcohol and Tobacco Tax and Trade Bureau
www.ttb.gov
Bureau of Alcohol, Tobacco, Firearms and Explosives
www.atf.gov
7) Radiation
Radiation Studies Information (CDC)
www.cdc.gov/nceh/radiation/default.htm

8) CDC Laboratory Safety Manuals
www.cdc.gov/biosafety/publications/index.html
9) Occupational Safety and Health Administration
www.osha.gov
Safety and Health Topics:
www.osha.gov/SLTC/
www.osha.gov/SLTC/reactivechemicals/index.html
www.osha.gov/SLTC/laserhazards/index.html
www.osha.gov/SLTC/radiationionizing/index.html
10) U.S. Nuclear Regulatory Commission
Material Safety and Inspection Branch
One White Flint North
11555 Rockville Pike
Rockville, MD 20852
phone: 301-415-8200; 800-368-5642
www.nrc.gov

C. Putting It All Together

1. **Topic Proposal**
   a. General **Areas of Interest**. Choose the area in which you are most interested. Science Fair categories are broken up as follows:
   Please visit the website https://www.societyforscience.org/isef/categories-and-subcategories/ for a full description and definition of ISEF categories (subcategories may adjust):

ANIMAL SCIENCES
Animal Behavior
Cellular Studies
Development
Ecology
Genetics
Nutrition and Growth
Physiology
Systematics and Evolution
Other
BEHAVIORAL & SOCIAL SCIENCES
Clinical & Developmental Psychology
Cognitive Psychology
Neuroscience
Physiological Psychology
Sociology and Social Psychology
Other
BIOCHEMISTRY
Analytical Biochemistry
General Biochemistry
Medicinal Biochemistry
Structural Biochemistry
Other
BIOMEDICAL AND HEALTH SCIENCES
Cell, Organ, and Systems Physiology
Genetics and Molecular Biology of Disease
Immunology
Nutrition and Natural Products
Pathophysiology
Other
BIOMEDICAL ENGINEERING
Biomaterials and Regenerative Medicine
Biomechanics
Biomedical Devices
Biomedical Imaging
Cell and Tissue Engineering
Synthetic Biology
Other
CELLULAR AND MOLECULAR BIOLOGY
Cell Physiology
Cellular Immunology
Genetics
Molecular Biology
Neurobiology
Other

CHEMISTRY
Analytical Chemistry
Computational Chemistry
Environmental Chemistry
Inorganic Chemistry
Materials Chemistry
Organic Chemistry
Physical Chemistry
Other
COMPUTATIONAL BIOLOGY AND BIOINFORMATICS
Computational Biomodeling
Computational Epidemiology
Computational Evolutionary Biology
Computational Neuroscience
Computational Pharmacology
Genomics
Other
EARTH AND ENVIRONMENTAL SCIENCES
Atmospheric Science
Climate Science
Environmental Effects on Ecosystems
Geosciences
Water Science
Other
EMBEDDED SYSTEMS
Circuits
Internet of Things
Microcontrollers
Networking and Data Communications
Optics
Sensors
Signal Processing
Other
ENERGY: SUSTAINABLE MATERIALS AND DESIGN
Biological Process and Design
Energy Storage
Hydrogen Generation and Storage
Thermal Power
Solar Process, Materials, and Design
Thermal Generation and Design
Triboelectricity and Electrolysis
Wind
Wind and Water Movement Power Generation
Other
ENGINEERING TECHNOLOGY: STATICS AND DYNAMICS
Aerospace and Aeronautical Engineering
Civil Engineering
Computational Mechanics
Control Theory
Ground Vehicle Systems
Industrial Engineering-Processing
Mechanical Engineering
Naval Systems
Other

ENVIRONMENTAL ENGINEERING
Bioremediation
Land Reclamation
Pollution Control
Recycling and Waste Management
Water Resources Management
Other
MATERIALS SCIENCE
Biomaterials
Ceramic and Glasses
Composite Materials
Computation and Theory
Electronic, Optical, and Magnetic Materials
Nanomaterials
Polymers
Other
MATHEMATICS
Algebra
Analysis
Combinatorics, Graph Theory, and Game Theory
Geometry and Topology
Number Theory
Probability and Statistics
Other
MICROBIOLOGY
Antimicrobial and Antibiotics
Applied Microbiology
Bacteriology
Environmental Microbiology
Microbial Genetics
Virology
Other
PHYSICS AND ASTRONOMY
Atomic, Molecular, and Optical Physics
Astronomy and Cosmology
Biological Physics
Condensed Matter and Materials
Mechanics
Nuclear and Particle Physics
Theoretical, Computational, and Quantum Physics
Other
PLANT SCIENCES
Agriculture and Agronomy
Ecology
Genetics and Breeding
Growth and Development
Pathology
Plant Physiology
Systematics and Evolution
Other

ROBOTICS AND INTELLIGENT MACHINES
Biomechanics
Cognitive Systems
Control Theory
Machine Learning
Robot Kinematics
Other
SYSTEMS SOFTWARE
Algorithms
Cybersecurity
Databases
Human/Machine Interface
Languages and Operating Systems
Mobile Apps
Online Learning
Other
TECHNOLOGY ENHANCES THE ARTS
Display Technology
Human Information Exchange
Music and Image Manipulation
Games
3D Modeling
Engineering Effects
Other
TRANSLATIONAL MEDICAL SCIENCE
Disease Detection and Diagnosis
Disease Prevention
Disease Treatment and Therapies
Drug Identification and Testing
Pre-Clinical Studies
Other

b. Once you have chosen an area, begin to narrow it down further and further until you have a single topic of focus. This topic becomes your problem, and should be in question form.

c. Library research will aid you in narrowing your topic. You must use the library to complete this project. Unfortunately, the Marian Library is not sufficient to provide all the resource information you will need. Also, do not be afraid to contact professors at IUSB, Notre Dame, or St. Mary's for help with developing your ideas. They are a valuable resource for equipment, as well.

d. Research resources

(1) Check with local school corporations regarding equipment, resource staff, moneys available, release time, recognition and emotional supports.

(2) Get topic ideas from hobbies, personal interests, items in newspapers or magazines.

(3) Get reference materials from school, public, or university libraries; or teacher advisor materials.

(a) -write letters

(b) -use interlibrary loans

(c) -do computer searches

(d) -study previous student papers

(a) -use computer Internet services

(4) Telephone hospitals, universities, businesses, or professionals with questions. Start a file of addresses and numbers.

(5) Consult science catalogs to develop a list of materials and costs. Develop a budget.

(6) Read professional pamphlets, fliers and magazines. Note research grants available for students.

(7) Visit hospitals, universities and laboratories. Learn research techniques.

e. When you have chosen your problem, complete and turn in Preliminary Discussion of Research Proposal form by stated due date (See Appendix A).

2. **Topic Suggestions**

a. Due to previous overuse, lack of cohesive experimentation, or simply because they are too simple for a high school level project, the following topics **MAY NOT** be used:

1. The Effect of Colored Light on Plants
2. The Effect of Various Household Chemicals on Plants
3. Mold Growth
4. "How Simple is That Sugar?"
5. Dreams
6. Acid Rain Effects and the Use of Limestone to Remediate Them
7. Cancer in Plants – Crown Gall Disease and the Use of *Agrobacterium tumefaciens*
8. The Effects of Fertilizers on Plants
9. Hydroponics
10. The Effect of Music on Plants
11. The Effect of Pollution on Plants
12. Cigarette Smoke/Lung Cancer
13. Bacterial Growth on Surfaces
14. "Microbes Cause Infection" (The Apple Thing)
15. The Effect of Different Substances on the Melting Time of Ice
16. Chromatography of Inks and Drink Mixes
17. What Type of Insulation Works Best?
18. Which Substance Cleans Teeth Best?
19. The Effectiveness of Baseball Bats – Wood vs. Aluminum
20. The Decomposition/Biodegradation of Paper in Different Soil Types
21. Crystal Growth
22. Are Clothes Fireproof?
23. Battery Life
24. The Effect of Video Games on the Cardiovascular System
25. Personality Types
26. The Effect of Color on Food Preference
27. Which cereal will best support a colony of mealworms?
28. Do earthworms respond to colored light?
29. Which color light will attract the most insects?
30. What food do birds prefer in an outdoor feeder?
31. Microwave Effect on Seed Growth
32. Can an evergreen be rooted from cuttings?
33. Will snails keep algae off the sides of an aquarium?
34. What type of soil do cacti/plants thrive in?
35. Planaria regeneration studies (pH, nutrients, etc.)
36. Will controlling root growth produce a Bonsai tree?
37. Antacids neutralizing stomach acid
38. The Stroop Effect
39. Different detergent effects on stains or different cloth types
40. Color of light on solar panels
41. The effect of caffeine on plants
42. The effect of tea on plants
43. The effect of various liquids (including different types of water) on plants
44. The effect of detergents/cleaners on stains
45. Testing soil pH
46. The effects of acid rain on plants/organisms
47. Testing pH of local water sources
48. Testing the amount of Vitamin C in fruits/vegetables
49. Growing plants in volcanic ash*
50. Mushroom Growth
51. The Effect of Temperature on Luminol
52. The Effect of Magnets on Plants
53. What additives can strengthen concrete?
54. Paper Airplane Modifications
55. Comparison of types of sports balls, bats, etc.

56. Electrolyte content of beverages
57. Any project designed specifically to kill any type of anumal

b. These Project Ideas may be used as a **starting point** to develop your own ideas:

1. Do insects have internal parasites?
2. Will aspirin change the pulse rate of an organism?
3. How will insects respond to pressure changes?
4. Can cockroaches truly survive extreme environmental conditions?
5. Will green mold on oranges inhibit bacterial growth?
6. Why might more insects be found in a field than in a forest?
7. Polytetrafluoroethylene – health risks?
8. Mussels as filters
9. Cholesterol control using roaches
10. Will a DC current have any effect on an ant colony?
11. Will a strong magnetic field have an influence on insects?
12. Effects of nutrient enrichment on algae growth
13. Crayfish dominance hierarchies
14. What soil pH is preferred by earthworms?
15. How will earthworms respond to low direct current in the soil?
16. Do pesticides injure earthworms?
17. Do land snails or slugs prefer light or dark?
18. Effect of electrode materials on fuel cell efficiency
19. Can an invertebrate survive in a sealed, balanced environment?
20. Will invertebrates show up on infrared film?
21. Does a mild soap solution affect invertebrates?
22. Is wasp nest paper more durable than manmade paper?
23. What food preferences do spiders have?
24. What is the intelligence level of invertebrates?
25. Does protective coloration really protect insects?
26. Will aquatic organisms do better in hard or soft water?
27. Will a strong magnetic field confuse aquatic organisms?
28. What color of light do aquatic organisms prefer?
29. Are aquatic organisms drawn towards sound vibrations?
30. Dinoflagellates as test organisms for metal toxicity
31. Can frog development be changed due to manipulation of their eggs?
32. Artificial light for solar cell charging
33. Will colored lights affect the mood of an animal?
34. Do animals other than dogs hear/react to dog whistles?
35. Does soft water really use less soap to clean than hard water?
36. Algae bioluminescence as a light source
37. The theory of combinatorial games
38. Can you copper plate silverware using DC or battery current?
39. Do insecticides affect organisms other than their intended targets?
40. Do plants affect the amount of humidity around them?
41. Measuring flood potential through soil porosity
42. What uses can be made of Bernoulli's Principle?
43. Can you transmit your voice over a light beam?
44. Would rollers beneath buildings help in an earthquake?
45. What device can show how steady a student's hand is?
46. Is it physically possible to copper plate insects/leaves/twigs/etc.?
47. Can you construct and program a robot to perform a practical duty?
48. What device can show how strong a student's grip is?
49. What are the advantages of the geometric shape of wasp and bee nests?
50. Will a heat cable in the soil speed plant germination and growth?
51. Will marigolds control nematodes in the soil?
52. What is the salt tolerance level of common plants? (This is different than testing salt water effects on plants)
53. Harnessing fuel from algae
54. Capsaicin as an antibacterial agent

55. Banana Peels as a fuel source
56. Do germinating seeds give off heat?
57. Bioactivity of Triclosan
58. Will fungi mycelium grow in nutrient gel?
59. Will fungi remove dyes from water/soil?
60. Computer/technology assistance devices for the visually-impaired
61. Effects of composting on crop growth
62. Orange peel polymers used for Drought Resistance
63. Will mildew attack all types of cloth fibers the same?
64. Does chlorine pollution affect plant growth?
65. Are plants affected by extremes in air pressure?
66. What sources were used for ancient pigments?
67. What sources were used for ancient medicines?
68. What effects do "antibacterial" products have on septic systems?
69. What good are air pumps in shoes?
70. Do natural weed killers exist?
71. Can toxic chemicals (like lead) be removed from the environment using natural sources?
72. How strong are synthetic polymers?
73. Plastic biodegradation
74. Does kernel color affect germination rate in corn?
75. *Pseudomonas* and *Penicillium* for bioremediation
76. Does creatine affect earthworm movement?
77. Does earwax have antibacterial properties?
78. Can Aloe vera function as a sunscreen?
79. Is there a functional use for discarded Chitin? (Crab leg shells, etc.)
80. Development of slime molds on mulch.
81. Is there a functional use for eggshells?
82. Is there a chemical way to separate the inner membrane from an eggshell?
83. Do individual Hydra cells segregate from each other in a mixed cell aggregate?
84. Will green and brown Hydra cells mixed in an aggregate separate from each other?
85. Effect of caffeine on seed growth after UV exposure
86. Allelopathy of different tree species
87. Biodiesel Fuel
88. Artificial Neural Networks in computers
89. Fungal degradation of compact disks
90. Cell phones and radar guns effect on *Drosophila* mutation
91. Wheelchair modifications
92. Liquid bandages
93. Antibiotic effects of plant extracts or herbs

94. Use of straw to control algae
95. Phytoremediation of water
96. Does ‘clean-up’ by perpetrator compromise DNA evidence?
97. Effects of toxic water plants on invertebrates
98. Lichens as pollutant indicators
99. Soil tests on roadsides where evergreens are dying
100. Natural larvicides like herbs on mosquitoes and Daphnia
101. Road salt effects on freshwater invertebrates
102. Arsenic percolation in playgrounds
103. Sarcodine bioremediation
104. Hydroponic phytofiltration
105. Antidepressants on crayfish
106. Pillbug pheromones
107. Effect of alcohol on cell cultures
108. Herbal mold retardants
109. Antioxidant effects on *C. elegans*
110. Alfalfa fire retardation capability
111. Acrylamide effects on cell cultures/DNA
112. Naturally colored silk
113. Non carbon dioxide car exhaust material – effects on plants
114. Facial recognition using ‘Faces’ program or sketch artists
115. Sulfur bioremediation
116. Antibiotic effects of honey
117. Cancer cell cultures – reactions to lycopene, etc.
118. Fungal bioremediation
119. Soundproofing insulation
120. Effects of chemicals on a spider’s web construction ability
121. Styrofoam as a strength enhancer for concrete
122. Chromatographic analysis of air or water pollution
123. Sodium benzoate as a fungus control
124. Nanoparticle delivery systems
125. Herbal remedy effects on worms
126. Protein variations in honey
127. Tannins as metal cleaners
128. Aloe vera as a termite pesticide
129. Natural antacids (*Solanum nigrum*)
130. Sunscreen effectiveness – silver nitrate and spectrophotometry
131. Peltier Effect – replacing freon in car air conditioning
132. Phytoremediation using ribbon ferns
133. Heavy metals vs. water plants
134. Phytopurification of drinking water
135. Oil extraction from seeds
136. Phytoremediation of ammonia
137. Spices as pesticides
138. Fish oils vs. breast cancer
139. Tea vs. cholesterol
140. Vitamin E vs. UV mutation
141. Lichens vs. *Staph.*
142. Natural vs. artificial sweeteners – *Drosophila* preference

143. Light wavelength effects on *Drosophila* reproduction
144. Plastic manufacture without petroleum
145. Using eggshells as a calcium supplement source
146. Ethanol production in grasses
147. Saliva as a pH buffer
148. Kudzu as a pesticide
149. Mycoremediation of oil-contaminated soil
150. *Rhue chalepensis* as a pesticide
151. Microbial fuel cells – construction and energy sources
152. UV absorbance of sunscreens in pool water
153. Celery extract as a coolant
154. Sustaining crop growth in a flooded area
155. Reduction of carbon dioxide emissions
156. Discovering the Iron Concentration in Eel Tanks and the Optimization of Aquaponics
157. The Prevalence of *Anaplasma* Morulae In Symptomatic Canines
158. The Study of the Pitch Preference of Canadian Rocky Mountain Gray Wolves
159. Increasing pasture productivity and equine health using a warm and cool-season rotational grazing system
160. Determining the Best Attractant in Order to Monitor Forest Carnivores
161. Predicting the Occurrence and Magnitude of Solar Flares Using Machine Learning
162. The Probability of Merging given Redshift, Galactic Mass and Morphology
163. Calculating atmospheric disequilibrium of exoplanets as a possible biosignature
164. TESS Updates to Plan JWST Observations for Atmospheric Characterization of Promising Exoplanets
165. The Effect of Metformin on Post Traumatic Brain Injury and Learning Disabilities
166. Using Electroencephalography to Discover Cognitive Differences Between Musicians and Non-Musicians
167. Evaluating the Relationship Between Concussion Knowledge and Reporting Tendencies in High School Athletes
168. Determining the Effects of Dietary Intake on Stress Level, Cognitive Functioning, & Physical Activity
169. The Impact of Time-Related Factors on the Effectiveness of Music as a Stress Reducer for Adolescents
170. Assessing Public Awareness and Understanding of Sepsis
171. The Social Effect of Linguistic Alignment on Speech Production and Comprehension
172. The Impact of Having a Sibling with Cancer
173. Evaluation of Student-Centered Learning Implementation by PreK-12 Grade Teachers
174. The Transition of Deaf or Hard of Hearing (DHH) Students from High School to College
175. The Impact of Psychosocial Interventions on the Quality of Life of Cancer Caregivers
176. Emotional and Social Impact of Autoimmune Diseases
177. Developing a Comprehensive Intervention Plan for Parents of Children with Autism with regard to Parental Stress and Training
178. S.O.S (Students Overcoming Stress) - Gaining Insight and Addressing Student Stress: Analyzing the Different Modalities of Stress and Mindfulness on Adolescents
179. Henna-Inspired Napthoquinones as Natural Materials for Green Li-ion Batteries
180. Chemical Modification of Cotton Fabric to be Hydrophobic and its Potential for Oil Absorption and Utilization in a System of Continuous Oil-Water Separation
181. The Controlled Production of Graphene Using Automated Mechanical Exfoliation
182. Preparation, Synthesis, and Device Integration of Aerogels of Varying Materials
183. Utilizing Dual Function Materials to Capture and Convert Carbon Dioxide into Sustainable Fuels
184. Using Self-Assembled Monolayers for the Fabrication of Implantable Strain Gauge Sensors
185. Improving the Efficiency of Thin-Film Photovoltaics by Understanding Non-uniformity

186.. Improving Methods of Detection and Removal of Pitch from the Papermaking Process
187. Use of Machine Learning to Improve the Early Detection of Bronchogenic Carcinoma
188. Methods for Investigation of the Effects of Spinal Cord Lesion on Motor Cortex Activity in Mice
189. Using Machine Learning Methods to Analyze White Matter Brain Activity in Children
190. Developing a Novel Hybrid Deep Learning Algorithm for Continuous Seizure Prediction
191. Computational Approach to Investigating Novel Pain-Management Therapeutics and DAMGO
192. Design of a Blockchain Protocol Scalability Comparison Apparatus Using Virtual Machines
193. Assessment of Quality of Life Before and After Deep Brain Stimulation
194. Segmenting Lung Lobe Structures using a Novel Artificial Intelligence Framework for Precise Lung Cancer Radiotherapy
195. Mobile RGBD Situational Awareness Aid for the Blind and Visually Impaired
196. The Effect of Grafted Bone and Dental Implant Location on Bone Loss
197. The Application of Computer Algorithms for the Diagnosis of Eye Diseases
198. Improving Accuracy in Security Systems using Biometric Recognition
199. Using Computational Modeling to Assess Cardiac Dyssynchrony
200. Automatic Seizure Onset and Severity Prediction with a Strategically-Placed, Bipolar EEG
201. An Algorithmic Approach to Short-Term Solar Forecasting Using Total Sky Imagers
202. The Biodiversity of Macromoths Relative to Suburban Development
203. Using a Natural Fungicide to Control the Tick Population that Transmits Lyme's Disease
204. Utilizing the Black Walnut as a Possible Algal Bloom Mitigation Technique
205. Effect of Changes in Nutrient Dynamics on *Microcystis aeruginosa* and how Algal Growth Affects Carbon Emissions
206. The Effect of Japanese Barberry (*Berberis thunbergii*) on Animal Populations in a Northeastern Forest
207. The Effects of Invasive Leaf Litter on Macroinvertebrate Colonization
208. Developing an Attachment for the Body-Powered Prosthesis Utilizing 3D Printing
209. Passive Solar Tracker Models to Enhance Photovoltaic Energy Gain
210. Harvesting Electricity from Human Motion Using ZnO Nanowires
211. Utilizing a Modified Electrostatic Precipitator for the Efficient Removal of Particulate Matter at its Origin
212. Self-Sustaining Piezoelectric Energy Harvesters with Varying Aspect Ratios
213. Sustainable Water Purification: Integration of Solar Distillation and Disinfection
214. Small-Scale Compost Heat Recovery System
215. Universal Injury Immobilization Device: An Effective Tool for Injury Management
216. A Collapsible Kayak with Unified Skin and Skeleton
217. Utilizing Drug Intervention to Inhibit Delayed Neuronal Death by Migrainous Spreading Depolarizations
218. The Effects of the Electrical Behavior of Myocytes on Cardiac Performance
219. Inhibition of sEH Rescues Nitric Oxide Bioavailability in Fructose-Fed Young Rats
220. Determining the Antiviral Function of XAF1 During Immune Response
231. Genetic Foundations for Responsiveness to Ibuprofen Treatment of Patent Ductus Arteriosus (PDA) in Extremely Low Birthweight Infants
232. The Role of Gene Therapy in Pulmonary Hypertension Associated with Lung Fibrosis
233. The Effects of a High Fat Diet on the Occurrence of Prostate Cancer
234. Recurrent Hypoglycemia Disrupts Central and Peripheral Circuits Regulating Glucose
235. An Investigation of Schizophrenia in Human Neurons
236. The Impact of Stress on The Susceptibility of Alcoholic Liver Disease
237. Identification of a Protective Memory Response in Babesia microti Infection

238. Spreading Depolarizations as Preconditioning to Ischemic Stroke
239. Utilizing Lift and Drag to Measure the Aerodynamic Efficiency of the Forward Swept Configuration
240. Using Audio as a Factor in Field of View Prediction

3. Background Information

a. Understanding **Science Journal Articles**

(1) All research scientists wish to publish. They are interested that the science community learns about their research findings. Since there are thousands of research projects going on each day, the reports must be technical, exact and concise.

(2) When reading a science journal article (one written for scientists, not the general public), you should follow these steps. (See 'How to Do a Literature Search' in Appendix A.)

(a) Photocopy the article - include the bibliographic information so you don't forget where you got the article.

(b) Read the article through once. Then take a break.

(c) Read the article a second time, detailing main points with a highlighter.

(d) Look for the researcher's hypothesis, the methods used, and the results. You should be able to identify:

i) Title of article and author(s).

ii) Hypotheses used.

iii) Focus of experiment. (What type organism, chemical, process, equation, etc.)

iv) Control and experiment groups.

v) Procedural steps with emphasis on measurements and units.

vi) Test types used (if standard).

vii) Results

viii) Category of research.

b. **Writing the Background Literature Summary**

(1) A background literature summary is simply a bibliography that includes a paragraph or two summarizing the main points of each entry. This is very similar to the process of making notecards for a term paper in English.

(2) An annotation (single entry) begins with the author's name in reversed order, followed by the title of the article in quotations, then the periodical is capitalized and underlined. The volume, page, and date are given as well. Skip a line after the reference information to begin text.

Sample Annotation

Bernstein, Neil P., 'Vegetational History of Mentor Marsh.' The Ohio Journal of Science. May 1981. Vol. 81, no. 3, pp.105-108.

Mentor Marsh is a remarkable wetland on the south shore of Lake Erie, east of Cleveland. It possesses a diverse number of plant species, several of which are not found elsewhere in Ohio Lake Erie wetlands...

--Points should be summarized in one (1) to two (2) paragraphs.

c. How **to find Research**

(1) Research material comes in many forms. This includes: journals, the Internet, books, magazines, texts, manuals, encyclopedias, people (written or interviewed), videos, audio tapes, etc. Most research for a science project will be found in a library. In this area, there are many libraries to choose from. Here is a list, from least helpful to most helpful.

(a) Marian Library - limited science research information.

(b) Public Library branches

i) Elkhart
ii) Mishawaka
iii) South Bend main libraries.

(c) IUSB Schurz Library

(d) Notre Dame Hesburgh Library

(2) These libraries usually have all research material referenced on computer.

(3) Notre Dame has split its scientific libraries between various buildings. Besides the main library building, you may need to find:

(a) Fitzpatrick Hall - Engineering library on first floor.

(b) Galvin Life Sciences Building--Life Science library on first floor.

(a) Nieuwlands Hall - Chemistry/Physics Library on second floor.

Maps of the Notre Dame Campus are available online.

4. **Writing the Hypothesis** (See also page 52)

a. A hypothesis is an educated explanation that attempts to answer your problem question. When forming your hypothesis, clarity of wording is extremely important. It should be brief, concise and narrowed in scope. A hypothesis should cover only one variable. You may have more than one hypothesis involved in your project.

b. A hypothesis should be stated as an answer to your problem question. Ideally, it is stated in an "If…then…because…" format.

c. Examples

(1) If the longevity of *Drosophila melanogaster* is inversely proportional to the concentration of DDT added to the food media during the egg-larvae stage of metamorphosis, then fewer flies will metamorphosize to adults because the DDT interferes with normal cell division and hormonal controls.

(2) If nitrogen influences the growth rate of *Zea* mays, then the inter-nodal stem growth during the first weeks following seed germination will be directly proportional to the concentration of nitrogen in the hydroponic solution, because the inter-nodal space is a direct measure of the plan's growth.

(3) If exposed to a sound frequency of 5,000 cps at a decibel level of ninety, then there will be no significant physiological differences between male and female lab rats, because there is no physiological difference in the auditory capacity due to gender.

5. **The Outline**

Before you begin experimentation, you need to plan your process step-by-step. The outline you make is different from the outline form you are familiar with. The Science Project outline is a form required for all projects by the International Science Fair Committee. It is more accurately called the Research Plan (see Form IA). This plan must be completed in full with all signatures, and turned in, by the stated due date. ***Note: For the following sections 5-9, see also descriptions under: E. Writing the Science Research Paper.**

6. **Materials and Methods** (See also page 53)

a. An important part of your science project is a detailed list of the methods used. The purpose of listing your methods is so that anyone who wishes to re-do your project can repeat it exactly the way you did it. In the world of Science research, scientists commonly repeat others' work to verify their findings and set up new modifications. It is important that your Methods outline be <u>as specific as possible</u>, including specific materials, brand names and measurements where applicable. Materials and Methods used solely for creating your backdrop (paper, pen, computer, etc.) are not necessary to include. There should be no separate listing of materials – they should all be described and incorporated into your Methods section.

b. Make **sure to use only Metric (S.I.) measurements when gathering data.**

c. As you can see from the Research Plan of Form 1A, a list of methods or procedures is needed before you begin your experimentation. Scientists refer to this list as the protocol of the experiment. It is necessary so that others may repeat your project. This list should be as detailed as possible, but may always be modified along the way.

7. **Data Collection**

This is the meat of your project. Be accurate, precise, and complete. **All measurements should be in metric units!!!!!** Your data should include the following:

a. Timetable - How often did you collect data? When did you start? When did you stop?

b. Accuracy - How accurate were your observations and measurements? Did you estimate? What did you compare non-numerical data to? Make every attempt to convert data to a measurable scale, i.e., Numbers.

c. Reporting - All data must be reported. It should all be recorded in a project databook (in ink!) Any data that does not fit your project's intent should not be removed. Any mistakes should be changed by crossing- out, not erasing. Data applicable to your project's intent must also be reported in the form of charts, tables and/or graphs. Use a computer program for this purpose.

d. Photographic Evidence - Take pictures from start to finish!!! This will be your only way to verify that you actually performed your experiment. Remember to end experimentation with enough time left before the due date to get your pictures developed. The one hour developing is very expensive. You may want to take duplicate pictures on separate rolls of film. Developing places have lost film in the past. With two rolls of film at different developers, you have a better chance. **All pictures must be included with the final project. Pictures of people must be accompanied by a signed release form for each person in the photograph.**

8. **Report on Results** (See also page 53)

This section is where your collected data is presented. It should include all the information outlined above. The basic difference between the Data section and the Results section is that Data presents your findings in graphic form (tables/charts/graphs), whereas the Results section presents the same information but in narrative/paragraph form.

9. **Discussion Section** (See also page 54)

The purpose of this section is to relate collected data to your problem. It is here that you explain if your hypotheses were supported by data or not, and how.

10. **Conclusions** (See also page 54)

This section reviews hypotheses and shows how general trends in data relate to them. Conclusions should repeat the problem and hypotheses of your project. The average person should be able to look at only your conclusions and understand what your project was all about. Conclusions should also include:

a. Sources of Error - What could possibly have caused any errors or inconsistencies in your data? Inaccuracy of measurements, human error, skipping a data point, too long or too short a time between data points, etc. can all be sources of error. List all that apply to your project and explain each.

b. Further Study - Include what could be done in the future to improve or continue your study.

c. A clear statement of the impact or necessity of the study.

d. A clear statement of the mentor's role in the project and the student's role in the project.

D. Backdrop Design

1. **Title** - Your title should be short and to the point. It should identify the focus of your project. You may wish to use your problem, hypothesis, or a restatement of either as the project's title. It does not have to be in question form. Here are some helpful hints on titles:

a. The title should be large, with big, easy-to-read letters. It should not, however take up most of your backdrop.

b. Stenciled letters should have spaces connected and filled in.

c. Do not use fancy style lettering of any kind. Use block letters only.

d. Center the title at the top of the display.

e. Use only one color for the title, preferably one of high contrast to the background.

f. Computer-printed titles are fine.

2. **Construction**

a. Your backdrop must stand by itself. Poster board will wilt over time, and is not acceptable for a backdrop. Wire hangers, rulers, dowels and tinker toys will also make for very poor backdrop supports. Your best bet is to use corrugated cardboard, fiber board, foam board, pegboard, wood or some kind of plastic/metal framework. The easiest thing to do is to purchase a Showboard type tri-fold display board. These are available through your teacher. Professional quality backdrops will be made available to projects advancing to competitions.

b. Size limitations for a project display are:

(1) 76 cm (30 in) deep

(2) 122 cm (48 in) wide

(3) 274 cm (108 in) high - tables are usually 76 cm (30 in) high

c. Presentation of Clear Information--Your backdrop must contain all information pertinent to your project. It is basically the only thing most people will see. The following sections should be included on your backdrop:

(1) **Title**

(2) **Problem**

(3) **Hypothesis**

(4) **Materials** & **Procedure** – Both included in the same section in outline or step-by-step format.

(5) **Data** (Graphs, tables, etc.) - make sure each is clearly labeled and credited.

(6) **Results**

(7) **Photographs -** a minimum of six for the final project – **Must have caption and credit**

(8) **Discussion**

(9) **Conclusions/Unanswered questions/Sources of error**

(10) **Bibliography (**a minimum of six references excluding encyclopedias)
(11) **Abstract**

d. Each of the above sections (except for title) should have its own heading. These can be purchased, or made yourself. This allows a viewer to locate the section of your project that is most interesting to them.

e. Information should flow smoothly. The above list is pretty much in order of how the information should be presented. Remember, since we read from left to right, your information should flow from left to right as well. With the title in the top center, the left side of the board should hold the Problem, Hypothesis, Materials, and Procedure. The center of the board should display the Results and the Photographs. All other information should be on the right. You do not have to set it up this way of it does not fit. Use your own judgment. The important thing is that your information flows from start of project to end of project.

3. **Appeal**

a. Besides presenting your information, your board's purpose is to attract attention. It should be visually stimulating without being obnoxious or painful. When in a room full of projects, yours should say 'look at me first' through its visual appeal.

b. Different methods to increase visual appeal.

(1) Bright colors. (Caution! - Colors that are too bright give people headaches, and they will not want to look at your project. Also, don't use too many different colors.)

(2) Pictures, photographs, drawings, graphs, tables, illustrations, etc.

(3) Balance - too much open space or overcrowding is bad.

(4) Matting - border each set of information with construction paper or matte-board.

(5) Clear lettering

(6) Heading labels

(7) Typed information

c. Hint: Use a computer program for illustrations. Most computers include some type of drawing or graphing program.

d. Use a *sans serif* type font (Arial, Calibri, etc.). Make sure the font size is large enough to be easily read when standing 2-3 feet away from your backdrop.

4. **Display Rules** (non-backdrop related)

   a. The following things **<u>may not</u>** be displayed:

      (1) Living organisms (plants, animals, microbes, etc.)

      (2) Dried plant materials (unless sealed in acrylic or other similar material)

      (3) Taxidermy specimens

      (4) Preserved animals

      (5) Soil or waste samples

      (6) Chemicals (including water) unless integral to an <u>enclosed</u> apparatus

      (7) Human or animal parts or body fluids

      (8) Human or animal food

      (9) Sharp items

      (10) Poisons, drugs, controlled substances, hazardous substances or devices

      (11) Dry ice

      (12) Flames or flammable material

      (13) Tanks that have contained combustible materials unless certified as having been purged with CO_2

      (14) Batteries with open top cells

      (15) Awards, medals, business cards, advertisements, etc.

      (16) Photographs or visual presentations depicting vertebrate animals in other-than-normal conditions (i.e. surgery, dissection, autopsy, or lab techniques).

      (17) Personal photographs, accomplishments, acknowledgments, addresses, phone or fax numbers, E-mail or web-site addresses.

      (18) All hazardous substances or devices (poisons, firearms, drugs, weapons, ammunition, lasers, etc.)

      (19) Glass or glass objects unless integral and necessary to the project

Items Allowed at Project or in Booth BUT with the Restrictions Indicated

(1) Soil, sand, rock, and/or waste samples **if permanently encased in a slab of acrylic**

(2) Postal addresses, World Wide Web and e-mail addresses, telephone numbers, and fax numbers **of Student Investigator only**

(3) Photographs and/or visual depictions **if:**

a. They are not deemed offensive or inappropriate by the Scientific Review Committee, the Display and Safety Committee, or Science Service. 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.
b. Credit lines of their origins ("Photograph taken by..." or "Image taken from...") are attached.
c. They are from the Internet, magazines, newspapers, journals, etc., and credit lines are attached.
d. They are photographs or visual depictions of the Student Investigator.
e. They are photographs of human subjects for which signed consent forms are at the project or in the booth. (Human Subjects Form 4 or equivalent photograph release signed by the human subject must be included in the paperwork and must be properly checked on the ISEF Official Abstract and Certification.)

(4) Any apparatus with unshielded belts, pulleys, chains, or moving parts with tension or pinch points **if for display only and not operated**

(5) Class II lasers **if:**

a. The output energy is <1 mW and is operated only by the Student Investigator
b. Operated only during the Display and Safety inspection and during judging
c. Labeled with a sign reading **"Laser Radiation: Do Not Look into Beam"**
d. Enclosed in protective housing that prevents physical and visual access to beam
e. Disconnected when not operating

(6) Class III and IV lasers if for display only and not operated

(7) Any apparatus producing temperatures that will cause physical burns if adequately insulated.

c. Restrictions

(1) Vacuum tubes or ray-generating devices must be shielded.

(2) Pressurized tanks must be secured.

(3) Apparatus producing temperatures that cause physical burns must be insulated.

(4) High-voltage equipment must be shielded with a grounded metal box.

(5) Wiring, switches, and metal parts must be insulated and have overload safety factors.

(6) Electric circuits for 125/220-volt AC must have a maximum of nine foot cord approved by Underwriters Laboratories.

(7) Electrical connections in 125/220-volt circuits must be soldered or made with UL approved connectors and insulated. (Maximums are 500 watts @130 VAC/60 hertz or 250 watts @ 220 VAC/60 hertz.)

(8) Bare wire and exposed switches may be used only in circuits of 12 volts or less.

(9) Handouts must be limited to one copy of the official abstract.

d. Necessities -Besides your backdrop you should also include:

(1) Your project databook or journal where you have recorded all data, procedures, etc.

(2) Abstract.

(3) Research paper, if required.

(4) All required forms, surveys, tests, etc. It would be best to attach folders with pockets onto the back of your display board to hold the above materials.

A. Writing the Science Research Paper

***It is important to note that various competitions require specific formats for papers. The rules provided by these organizations will supersede or enhance the rules provided here, as applicable.**

1. General Hints

a. Drafts and Rewrites

(1) Writing is difficult. Writing sensible sentences, paragraphs, and entire papers is nearly impossible on first attempts. All published authors write a first draft and then revise and rewrite it, usually several times. You must do the same.

(2) To make the job as easy as possible, the work should be broken down into sections (as an outline). Work on each section separately, and put the final copy of each section on an individual sheet. Do not put page numbers on until each section has been revised, proofread and assembled correctly.

b. Clarity and Concise Writing

(1) The use of needless and confusing words and phrases must be avoided. Information must be presented clearly with an absence of wordiness. Examples:

Wordy	Concise
at this time	that
due to the fact	that
because during the time	that
while for the reason	that because
goes under the name of	is called
if conditions are such	that if
in the event	that if
it is often the case	that often
often it would appear	that apparently
serves the function of	being is
it was discovered by Jones	that Jones discovered

(2) After completing your drafts, slowly read over your paper, eliminate excess words, and re-phrase awkward passages. Have someone else proofread it and do the same. Then have someone else read it aloud to you. Listen to see if it makes sense. If not, change it again.

(3) Remember the "Ten Rules" from English class:

1. Always write in third person.
2. Run-on sentences and fragments are never permitted.
3. Sentences must agree in number and gender.
4. A paragraph should contain at least five sentences.
5. Each paragraph should contain only one idea.
6. Spelling and proper punctuation <u>always</u> count.
7. Never abbreviate or use contractions.
8. Avoid clichés.
9. Never use the word THERE …Ever!
10. OF is not the same as HAVE. ALOT is not a word.

c. Paper and Writing Types

(1) If you choose to handwrite your report, (**which is not preferred**), use lined paper, or typewriter paper under which you have place lined paper as a guide.

(2) Use unpunched paper when possible. Be sure that it is good quality and standard size. Do not use recycled paper for reports! Never use paper torn from a binder. Paper torn from spiral bound notebooks is unacceptable, even if the edges are cut off. Do not use colored paper.

(3) Do your best to use a computer. Make sure that the printer prints dark letters. Clearly correct errors. Use as little correction fluid as possible, that is, retyping is better than white-out.

(4) Use one side of the paper only. If hand-written, use only black ink.

d. Format

(1) Number all pages in the upper right corner. Do not use periods after the number.

(2) Make at least two copies of your research paper. (It is much easier to do this if you use a computer and store the paper on a disk.)

(3) Reports will average about 5,000 words or 20 double-spaced pages.

(4) Double space the body of the paper. Use 12 point type. Choose from following fonts: HELVETICA, TIMES NEW ROMAN, COURIER NEW.

(5) Indent paragraphs five spaces.

(6) Leave four line spaces between a section and the next heading, if putting more than one section on a page. If only one section is on a page, center that section on the page.

(7) Leave two line spaces between the heading and the start of a section.

(8) Standard format:

(a) Title
(b) Abstract
(c) Introduction
(d) Problem
(e) Hypotheses
(f) Materials & Methods or Procedures
(g) Results (including data, graphs, etc.)
(h) Statistical Analysis
(i) Discussion of Results
(j) Summary and Conclusions (w/ sources of error)
(k) Works Cited
(l) Appendix (optional)

2. **Sections of the Research Project and Paper** - in detail

a. TITLE - Every scientific paper must have a title. The most important aspect about the title is that it be self-explanatory. That is, the reader should be able to tell, just by reading the title, what you have done without having to read the paper itself, a title, such as A BIOLOGY RESEARCH PROJECT, for example, tells the reader nothing. The reader has no idea whether your work involved an animal or a plant, or what you were measuring or testing. An example of a good title would be: THE EFFECTS OF LIGHT AND TEMPERATURE ON THE GROWTH OF THE BACTERIUM *ESCHERICHIA COLI*. In this example, the title explains what the worker has done; he has manipulated two environmental factors (light and temperature) to determine what the effects will be on the growth of a specific organism (*E. coli*). There are some exceptions to this guideline in which the author does not state all of the factors that were manipulated. The following title would be acceptable; EFFECTS OF VARIOUS CHEMICALS ON THE GROWTH OF *E. COLI*. In this case, the complete title would be too long. The same guideline applies if more than one organism is involved. For example; EFFECTS OF LIGHT AND TEMPERATURE ON THE GROWTH OF SEVERAL SPECIES OF BACTERIA. The researcher would, of course, include the names of the several bacteria in the text of the paper.

b. INTRODUCTION - The introductory section of the paper contains basic theory concerning the problem along with information on related investigations. The researcher states the purpose of the investigation, that is, the specific question(s) s/he is attempting to answer. S/He also describes relevant information he has been able to locate concerning the problem, including any research that has been done on the problem in the past. This is usually accomplished by a literature search in the library. All background information the researcher has gathered from textbooks and journals must, of course, be appropriately referenced. Any time a researcher mentions factual information in his paper that is not information he personally obtained (via his own experiments or observation) the researcher must include a reference to indicate the source of that information. This is referred to as 'citing the reference'. The first rule to remember when citing references in a science research report, is that footnotes are not used for this purpose. Footnotes are only used when additional explanation may be needed about data given on that page. If you have stated some factual information that needs to be cited, put the last name of the author of the source of that information in parentheses at the end of the statement. It should be followed by the page number it is found on. Example: Some birds eat only insects and obtain all the water they need from the insects they eat. (Smith, p.490) The Introduction Section will usually be the largest section of the report. In most cases, at least 75 % of this section would have been stored on a disk containing the initial proposal. It should be written in past tense and usually contains three (3) to five (5) double-spaced typewritten pages. The last paragraph ties together the introductory section with the remainder of the paper. It clearly states why the investigation is being performed. The following paragraph demonstrates this important element of a paper.

(Taken from Kim McIntosh's research paper)

Aedes albopictus is a major vector (i.e., carrier and possible transmitter) of arboviruses (i.e., viruses that can replicate in both vertebrates and arthropods) and dengue fever virus in other countries. They are also easily infected by parasites, some of which currently have not been found to harm humans or other animals (O'Meara, p. 169). As a result of these factors, the potential for *Aedes albopictus* "to become a major vector of arboviruses of public health importance may increase" (O'Meara, p. 171). Other aspects that increase the possibility for *Aedes albopictus* as a vector are its tendencies to bite a wide variety of species and the proximity of its environment to areas of human habitation (Stevens, p. 10A). Since *Aedes albopictus* has the ability to live in varied climates and temperatures, some scientists feel that they will begin spreading to the northern regions of the United States. *Aedes triseriatus* is the most common mosquito found in Indiana. Since *Aedes albopictus* dominated this mosquito in Florida, it would probably do the same in Indiana. Therefore, discovering how *Ascogregarina taiwanensis*, the common parasite in *Aedes albopictus*, affects the mosquito's size, and in turn its reproduction rate, may be a potentially effective way to control these mosquitoes if they migrate north as expected.

c. PROBLEM – Make a clear statement of not less than 4 sentences explaining the subject/question you are investigating. This section should end with a question.

d. HYPOTHESIS(ES) TESTED - This section, although very important, will likely be brief. Clarity of wording is extremely important. The following examples will demonstrate good form. Note that the hypotheses were not taken from the same research project.

(1) The longevity of *Drosophila melanogaster* is inversely proportional to the concentration of DDT added to the food media during the egg-larvae stage of metamorphosis.

(2) The inter-nodal stem growth during the first weeks following seed germination of *Zea mays* is directly proportional to the concentration of nitrogen in the hydroponic solution.

(3) There will be no significant physiological differences between male and female lab rats when exposed to a sound frequency of 5,000 cps at a decibel level of 90.

e. MATERIALS AND METHODS - In this section (which should be combined), the researcher explains HOW and WHERE he did his/her work. S/He describes the experimental design, experimental apparatus, methods of gathering data and the type of control. If any work was done outdoors in a natural habitat, the researcher describes the exact location and explains when s/he did his work. If any specimens were collected for study, their locations must be recorded and a time reference given. The basic rule to follow is that the procedural steps and materials section should be detailed and clear enough that any interested reader could duplicate the experiment if s/he wished. A second rule to review is that these sections should be written in the past tense.

(1) The following two procedural steps are poorly written.

(a) First pour six petri dishes full of agar, then inoculate them with fungus.

(b) I put the dishes in an oven and then looked at them the next day.

(2) The following steps would be acceptable

(a) Six petri plates were prepared with TSA agar and inoculated with the fungus *Aspergillus flavus*. (From microbiology department, Notre Dame).

(b) The inoculated plates were then placed in an incubator at 40°C for 24 hours.

(3) Generally, it is not necessary to describe equipment, unless it is specifically built for your project. In such a case it would be necessary to describe in detail, perhaps in the appendix, the equipment. Sometimes a sketch is included.

f. DATA and RESULTS - When a researcher presents data to the scientific world s/he tries to make that data as easily understandable as possible. S/He puts that data into a form that easily shows the reader any correlations, relationships or patterns that are important. Two widely used methods for doing this are tables and graphs. A table is the most efficient method of presenting numbers. The table classifies the data, and its organization should be self-evident. Because the numbers in a table usually could be arranged in several different ways, it is desirable to try several different forms and select the one that will demonstrate the results to the reader most effectively. All tables should have a title and all columns on the table should be properly identified. Although the table may be the most effective way of presenting the findings, it may not be the clearest to understand or the easiest in which to detect a trend. Where space is not a problem, as in this paper, both graphs and tables containing the same data are often used. Usually, one variable is dependent on a second variable. Mathematical examination shows that one is a function of the other, or that $y=f(x)$. The length of a growing animal varies with time, not vice versa. The absorption of light by a solution depends on the concentration of the solute. Either you control the factor and measure its effect or you observe the relationship with some uncontrollable factor, like time. In either case, the effect goes on the vertical axis and the independent variable goes on the horizontal axis. For both tables and graphs, where the data are expressed in inconveniently large or small numbers, it is often best to indicate in the heading that all entries contain a common factor. Line graphs should be used for Continuous Data (i.e. growth). Bar graphs should be used for discontinuous data.

The degree of significance should also be determined and noted using some test of significance, such as **Student-t**, **Z**, **N**, **ANOVA**, **Chi-square**, etc. (See section G.) Where appropriate, the formula for linear regression and the value for the correlation coefficient should be included on the graphs and/or tables.

g. DISCUSSION OF RESULTS - The results mean nothing unless they are related to the problem. The main purpose of your report is to communicate your findings, however, if the reader sees no significant trend in your findings and if the trends are not identified, the whole project and paper have been a waste of time. The data in the results section may not be associated with the correct hypotheses by the reader. In the discussion of the results section, one would again restate the tested hypothesis and then generalize about the data related to that hypothesis. It is in this section that one clearly indicates if the hypothesis was supported by the findings. It is quite proper to list the hypotheses one at a time and look at the gathered data. One must be careful of the way in which the data are interpreted.

(Taken from John Andrew's work)

In this experiment, the hypothesis was partly supported. As the graphs read, the static coefficient seemed to increase with mass, yet surface area did not cause an increase in either coefficient. It appears that mass had an effect because of the forces involved in friction, all which depend on mass, shown by the equations:

$$\mu_s = \frac{mg\sin\theta_s}{N} = \frac{mg\sin\theta_s}{mg\cos\theta_s} = \tan\theta_s$$ and $$\mu_k = \frac{mg\sin\theta_k}{N} = \frac{mg\sin\theta_k}{mg\cos\theta_k} = \tan\theta_k$$

The results produced may have been more conclusive with better and more precise equipment, yet they did show some results.

a. CONCLUSIONS - By this point in the paper, the conclusions should have become clear to both the writer and the reader. However, not all people take the time to read the report and look at the data. Many researchers read only the hypotheses and the conclusions-at least initially. In general, the conclusions would review the hypotheses and the general trend of the collected data related to the hypotheses. The conclusion section should contain sources of possible error, as well as any future action that is planned.

Never, ever use the word "prove" in a science project or report.

i. WORKS CITED - In all such studies, you will refer to some specific articles and make indirect references to other books or papers. You should identify all such resource materials. Basically, in this section, you would list the references alphabetically, by author. Use the Marian Style Guide for correct bibliography form. You should be using the MLA style of reference citation. IMPORTANT: By using the system noted in section b. INTRODUCTION and section h. WORKS CITED, there is no need for a footnotes or endnotes page, all you need is a Works Cited page!! **For this project, you should always have a minimum of six (6) resources.**

j. APPENDICES--Appendices are optional parts of a science research paper. They may contain necessary information that is not an integral part of the experiment(s) performed. They may also include photographs, and other information that you do not wish to include in the main paper. Appendices should be labeled by capital letters. If there is only one appendix, no letter label is necessary.

k. COVER PAGE

(1) Title is centered and placed about one quarter below the top. It should be all in capitals unless lowercase letters are necessary (as in pH).

(2) Your name, centered, with initials capitalized only, is placed half way down from the top.

(3) The following information should be in the lower right corner:

(a) Teacher's name

(b) Class name and hour

(c) Date

l. Additional Notes

(1) Do **not** use folders, report covers, etc.

(2) Use only one or two staples in the left corner to attach pages.

(3) **Proofread** your paper at least twice, and have two other people proofread it as well.

F. Abstract

1. The purpose of the abstract is to present the key points of your project and report, giving a quick, basic understanding of important information and findings. It should be a maximum of 250 words long, and never more than three paragraphs (usually only one). Use all the word allotment that you have. Many times, it is the abstract that determines whether a judge wants to look at your project in more detail. You should take time and effort to make sure it is well-written and descriptive.

2. An abstract should include the purpose of the experiment and the procedures used, as well as a summary of the data and conclusions. It may also include any possible research applications.

3. The abstract should be the last part of the report to be completed, although it appears just after the cover page.

4. The abstract should begin with the following information (no indentations):

   a. TITLE **(ALL CAPITALS)**

   b. Your **name, last name first**

   c. Your **full address**

   d. Marian **High School, Mishawaka, IN** (skip one line only)

5. The body of the abstract should be single-spaced with no indentations. The entire abstract (including the above information) **must fit in a space 5-1/2 inches high by 6 inches wide.**

6. Use a Serif type font and make sure the ink cartridge is good and will print dark letters.

7. See Mr. Andrzejewski for samples. See the website in Appendix B for form.

G. Statistics

1. Your data will be much more accurate and valid if run through a statistical analysis. This will determine if your collected data varies from expected results, and whether the difference falls within the realm of chance, or is significant to your study. These analyses should be included in your data section. All projects should minimally show an analysis of Central Tendencies of the data (mean, median, mode, standard deviation). Advanced course projects should minimally include a Student T Test.

2. Analysis of Central Tendencies and Student T test instructions are available from your teacher. Different types of statistical analyses are also available from your teacher. We also have many of these analyses on computer programs.

H. Poster Presentation

1. The Poster Presentation is a common method of reporting progress in an ongoing experiment. It is a miniature version of your final presentation, designed to show what progress has been made in the first stages of your investigation.

2. This presentation is made on a typical posterboard. It should fit onto the front side only, with no overlap. If you find that you have too much for one poster, then you must edit your information.

3. The Poster Presentation should include the following:

a. The **Title** of your project in question form. (This should be large enough to stand out, but should not take up a large amount of room on your board. Keep it plain and simple.)

b. Problem - a minimum of **four (4) sentences** that gives background knowledge of your experiment, ending with a question that can be answered by your hypothesis.

c. Hypothesis**(es)** – a proposed answer, potentially written as an "if…, then….because" statement
or
Engineering Goal – a statement describing the development and use of the final product

d. A separate Materials list is not needed. All materials should be included in the Methods or Procedures list.

e. Procedure **used thus far** - a step-by-step set of instructions written clearly enough so that anyone can repeat your experiment.

f. **Preliminary Data** - this is where you place tables and graphs. All tables and graphs should include a one line explanation below them, summing up what they represent. This is where you show calculations, pictures, and diagrams of your experimental setup.
-Use **metric measurements** at all times.
A minimum of three photographs is required.

g. Results - explain the meaning of your tables, graphs, and calculations in a **minimum of four (4) sentences**.

a. **Discussion** - restate your hypothesis, tell whether it was **supported or not supported** and why, and list any sources of error. Remember, never use any form of the word "prove".

i. Current **conclusions**, **future course of action, and errors**
- What would you change about this experiment?
- Did this experiment raise new questions?
- What were these questions?
- What direction will you take for the remainder of your project?

j. Bibliography (which may be on the back of the poster)

Suggested format for Poster Presentation

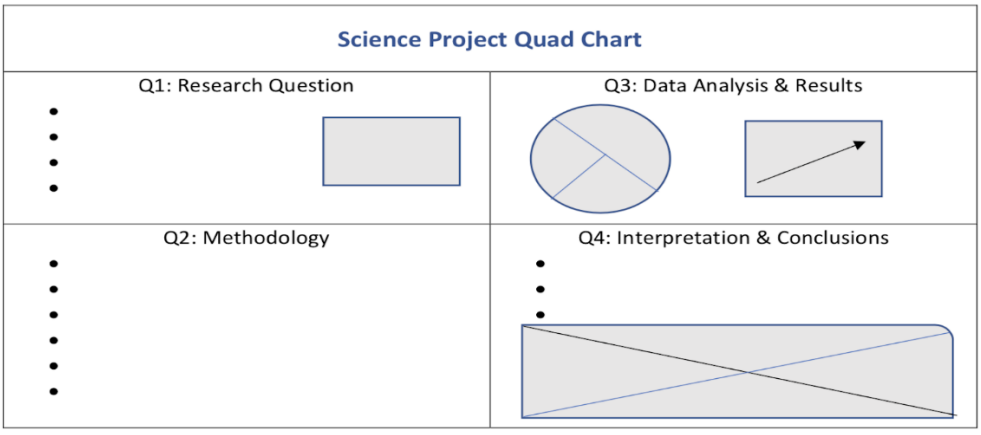
TITLE

Problem	Data (Tables/Graphs & Pictures)	Discussion
Hypothesis		Conclusion and Future Action
Materials & Procedures	Results	Bibliography

I. Science Project Poster Presentation - Quad Chart Format

A "quad chart" is a single page divided into four quadrants providing a high-level summary of the project. It is intended to be more visual than detailed in order to introduce what is happening with your project. Follow the model below that corresponds to the Project Presentation template you selected (either for a Science Project or for an Engineering Project.)

1. You must use a Standard sized poster (typically about 22 x 28 inches).
2. The poster background color must be white.
3. Text color must be predominantly black, but limited color for emphasis is acceptable.
4. The minimum allowable font size is 14 pt. Exception: You may use a smaller font size, down to 10 pt., for figure captions or photo credits.
5. The four quadrants of your Quad Chart do not need to be the same exact size, but they should be fairly similar, with a single border line delimiting each, as in the examples below. The Title section should be only as tall as necessary to include your project title and other identifying information
6. The Quad Chart should include a bibliography on the back of the poster. (5 reference minimum)



Engineering Project Quad Chart	
Q1: Engineering Problem & Project Objectives	Q3: Data Analysis & Results
Q2: Project Design	Q4: Interpretation & Conclusions

J. Presentations

1. You may be required to give a 10-15 minute presentation on your project. You will need to use your backdrop for this. You may bring in other props, videos, etc. to aid your presentation.

2. Suggested format

   a. State your title and explain it.

   b. List an aspect which nearly everyone has heard or read about, i.e. benefits of exercise, etc.

   c. Discuss the work of previous researchers

   d. State the reason for your investigation.

   e. Describe your experiment.

   f. State your hypotheses.

   g. Review your procedures.

   h. State the results and conclusions.

   i. State the uncertainties and sources of error.

   j. Ask for questions...

3. A PowerPoint Presentation will also be required. Information about this will be given to you by your instructor. Rules pertaining to PowerPoint Presentations are determined by the Junior Science and Humanities Symposium sponsored by the U.S. military.

II. Grading

The science research project comprises a major portion of your grade. Worksheets, outlines, proposals, presentations, and the research paper are all included for your semester total.

Grading Outline Total Worth--**250** possible

1. **Design**--Subtotal **30** pts.

    a. Neatness**: 5**

    b. Typing**: 5**

    c. Organization**: 5**

    d. Clear **Labels: 5**

    e. Visuals**: 5**
    --includes photos, drawings, diagrams, mattes, etc.

    f. Construction**: 5**

2. **Experimentation Verification** --Subtotal **30** pts.
--Photographs from duration of project showing progress as well as distinct experimental and control groups. Additionally, projects involving surveys or questionnaires must show **all** surveys or questionnaires.

3. **Data/Report**--Subtotal **100** pts.

    a. Title**: 5**

    b. **Hypothesis: 5**

    c. **Problem: 5**

    d. Procedure**: 10**

    e. Data**: 20 --** must be presented in a quantitative manner.

    f. Central **Tendencies/Statistics: 10**

    g. Abstract**: 10**

    h. **Results: 10**

    i. **Discussion: 10**

    j. Conclusions**: 10**

    k. Bibliography**: 5**

4. **Quality**--Subtotal **90** pts.

   a. Scientific **thought/complexity: 50**
   (Clear and concise problem; limited variables; adequate data; future research possibilities; use of literature; time involvement; how much was actually done by student; reliance on consultant; sources of equipment; site of experiment; repeat project sufficiently different; appropriate to ability level)

   b. Creativity**: 30**
   (Question asked; approach to solution; analysis of data; interpretation of data; equipment used; new equipment design; similarity to published experiments)

   c. Sources **of Error and Future Action: 10**

III. Opportunities

For motivated students, learning is not done for the sole purpose of getting good grades. The opportunity to better understand how processes function within the universe and to apply knowledge learned in the classroom to the real world should be the ultimate goal of education. Below is a list of science opportunities in which some of you may be interested. Because of certain limitations no one can be actively involved in all of them. We will try to advise you and help you prepare the necessary forms or proposals. More opportunities exist than are listed here. See your Science Research Director for current information and additional opportunities.

1. **REGENERON SCIENCE TALENT SEARCH** -scholarships, trips, discussions with professional scientists. Student must be in top 5% of graduating class. No vertebrate animal experimentation can be entered. An extensive application must be completed by the November deadline.

2. **INDIANA SCIENCE TALENT SEARCH** -scholarships, trips, discussion with scientists, tours of research facilities You can enter your research paper from this Research Program. Vertebrate animal work **CAN BE** entered. A brief application must be completed. (Usually, papers are due in September/October for a October/November competition.)

3. **NORTHERN INDIANA REGIONAL SCIENCE AND ENGINEERING FAIR** AT NOTRE DAME -awards, recognition, opportunity to exchange ideas with other science students and professional scientists. Usually held between late February through mid-March.

4. **THREE RIVERS SCIENCE SYMPOSIUM**--Scholarships and guided investigations in advanced science techniques at St. Francis College in Fort Wayne. Held on a Friday and Saturday in October and March.

5. **INDIANA JUNIOR SCIENCE AND HUMANITIES SYMPOSIUM**--Awards, trips, discussion with scientists. Deadline for applying is about Dec. 1st for March presentations.

Acknowledgments

The following sources have been instrumental in the compilation of information in this guide. This guide would not have been possible without these valuable sources.

A. Advancing STEM Research Teaching (ASRT) and Michael Blueglass

B. Blakeman, John--Perkins High School, Sandusky, Ohio

C. IUSB

D. Longenecker, Nevin--John Adams High School, South Bend, Indiana

E. Marian High School English Department

F. Purdue University School of Agriculture

G. Society for Science (International Science and Engineering Fair)

H. Showboard, Inc.

I. Sollenberger, Harold--East Noble High School, East Noble, Indiana

J. University of Notre Dame

Technical Assistance

A. Original Typing: Anita Guerra, Ken Andrzejewski, LeRoy & Mary Castle

B. Duplication: Janet Tricker

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F. Web page Assistance: Byra Warner, Mark Kirzeder

APPENDIX A

WORKSHEETS

Science Research Program - Finding a Topic, Part 1

POSSIBLE AREAS OF RESEARCH

1. **Animal Science** - Animal genetics, ornithology, ichthyology, herpetology, entomology, paleontology, circadian rhythms, cytology, physiology, studies of invertebrates.
2. **Astronomy/Space Science** – Physical properties of objects in space, computational astronomy.
3. **Behavioral and Social Sciences** - Human + animal behavior, psychology, sociology, anthropology, archaeology, linguistics, learning, perception.
4. **Biochemistry** - Chemistry of life processes, molecular biology, molecular genetics, enzymes, photosynthesis, blood chemistry, protein chemistry, hormones.
5. **Cellular & Molecular Biology** - Structure, function, intracellular pathways, and formation of cells, understanding life and cellular processes.
6. **Chemistry** - Physical chemistry, organic chemistry, inorganic chemistry, materials, plastics, fuels, pesticides, metallurgy, soil chemistry.
7. **Computational Biology/Bioinformatics/Biostatistics/Translational Medical Science** – Using computer science and mathematics to study biological systems including; Biomodelling, Epidemiology, Evolutionary Biology, Neuroscience, Pharmacology as well as, Disease Detection and Diagnosis, Disease Prevention, Disease Treatment and Therapies, Drug Identification and Testing, Pre-Clinical Studies
8. **Computer Science** - Hardware + software engineering, graphics, data structures, encryption.
9. **Earth Science** - Geology, mineralogy, oceanography, meteorology, climatology, seismology, geography.
10. **Engineering** - Civil, mechanical, aeronautical, chemical, electrical, photographic, sound, automotive, marine, heating and refrigerating, transportation, environmental.
11. **Environmental Science** - Ecology, pollution studies.
12. **Materials Science** – Biomaterials, Ceramic and Glasses, Composite Materials, Electronic, Optical, and Magnetic Materials, Nanomaterials, Polymers.
13. **Mathematics** - Calculus, geometry, abstract algebra, number theory, statistics, complex analysis, probability.
14. **Medicine and Health** - Diseases/health, dentistry, pharmacology, pathology, ophthalmology, nutrition, dermatology, allergies, speech + hearing.
15. **Microbiology** - Bacteriology, virology, protozoology, fungi, bacterial genetics, yeast.
16. **Neuroscience** – Neurology and cognitive neuroscience.
17. **Physics** - Music, optics, acoustics, atomic, particle, superconductivity, thermodynamics, semiconductors, magnetism, quantum, mechanics, biophysics.
18. **Plant Science/Botany** - Agriculture, agronomy, horticulture, forestry, taxonomy, physiology, pathology, genetics, hydroponics, algae.
19. **Robotics and Intelligent Machine** – Biomechanics, Cognitive Systems, Control Theory, Machine Learning, Robot Kinematics
20. **Systems Software** – Algorithms, Cybersecurity, Databases, Human/Machine Interface, Languages and Operating Systems, Mobile Apps, Online Learning
21. **Technology Enhances the Arts** – Display Technology, Human Information Exchange, Music and Image Manipulation, Games, 3D Modeling, Engineering Effect

Step 1: Choose a minimum of three areas of interest (topics). Do a Google search for and describe two major advances that happened in the last 30 years for each topic.
Include:

A. the advancement,
B. explain the impact,
C. the year it happened,
D. website

Step 2: For each advancement, pick two key words or key phrases that would help you do a more specific search.

Science Research Program -Finding a Topic, Part 2

Goal: To explore potential project ideas in your research area of interest.

Preliminary questions: Before you select potential project ideas, remember to consider the following:

1. How much time do you have to complete the project?
2. What time of year will you need to complete the project (may impact certain projects such as environmental projects)?
3. Will you need specific training and/or equipment? Is that available at your school? Locally? Online?
4. Will you be able to find people to help guide you through the project ("mentor")?
5. Will the project be eligible to be included in all different Science fairs/STEM competitions?

Research areas to avoid:

- Forensic science
- Behavioral studies with drugs, sex, depression, alcohol, eating disorders.
- Solar cells (may be ok but be careful with proprietary research)
- Firearm or explosive research
- Cannabis or CBD or other related topics
- Medical Projects involving:
    - prescription drugs
    - DEA-controlled substances
    - alcohol and/or tobacco products
    - radiation

Part A:

Step 1: Go to the Marian website https://www.marianhs.org/ then click on Academics and then click on **Loesch Family Library**. On the right hand side, click on **Research Tools**.

This will get you to the Gale databases. Please note that you must use a Gale Access Code (provided on that page) if you are using a non-Marian computer.

Click on the **Science icon** (you may also want to use the **Environmental Studies** or **High School** icons, depending on your project.)

Click on **Advanced Search** (under the white Search bar).

Type in a topic – be as specific as possible to begin with, and then use less specific topics as needed.

Under **Search Limiters**, do not check anything.

Under **Publication date(s)** check:

- All Dates

Under **Content type** click on:

- Select All

Do not enter anything on the rest of the choices.

Click **Search.**

Step 2: Read and Review at least 6 sources that are related to your area(s) of interest. If there are sources for Experiments, they are the best choices. Otherwise, Look under Academic Journals.

You may have to refine your search several times before you get what you need.

Step 3: Copy and paste all of the information for 4 projects into a word doc./Google doc.
This should include information about the researcher or author.

Step 4: Print and bring to class.

Part B:
Step 1: Go to the "ISEF project database" https://abstracts.societyforscience.org/

- ❖ Go to the drop down where it asks you to select a specific category and select whichever one is closely related to your area of research interest.
- ❖ On the bottom select "All/Any abstracts" and "All years"

Step 2: Read and Review at least 6 related abstracts.

Step 3: Copy and paste **3 abstracts for your area** of research into a word document. This should include information about the student researcher which is found below the title.

Step 4: Print and bring to class

RESEARCH PROPOSAL FORM

Name_____
Category of Research (from p.27-30) _____

1. General title of research proposal:

2. What is your research problem?

3a. What is your hypothesis? State your hypothesis in If …, then …, because … format.

3b. What is your engineering goal?

4. Describe your experimental set up and control OR if an engineering project, your engineering design.

5. Suggested timeline per month, October through January.

6. Why do you want to research this topic?

7. List six (6) keywords or terms likely to be associated with your proposed area of investigation. (These will help you in your Literature Search.)

_____ _____ _____

_____ _____ _____

Instructor's Approval

Parents' Approval

_____

_____

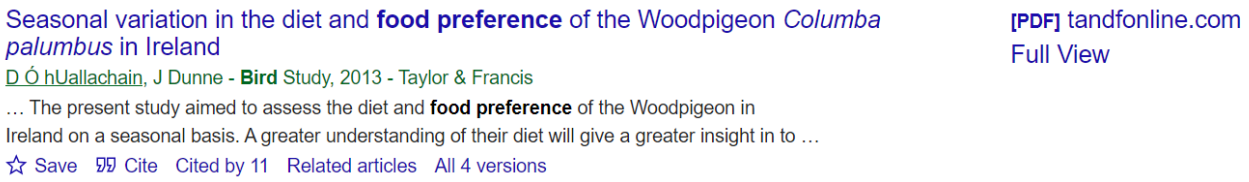
HOW TO DO A LITERATURE SEARCH

When beginning a research project in Science, or any subject, it is important to investigate and collect some background information on your chosen topic. An important way of doing this is to perform a Literature Search.

A Literature Search is the first step (after choosing your topic) in doing a research paper or annotated bibliography. In this exercise, you will do a short Literature Search on your chosen subject. **Follow the steps carefully.**

1. Locate a **minimum** of six (6) references that relate to your chosen topic. They can be exact matches, or only indirectly related to your subject. For example, a study on how light affects plant growth could use references dealing with that exact subject, or with light, plant growth, plants in general, etc.

--Use the six (6) keywords from your topic proposal to search through the reference systems at libraries, or the Internet.
Use Google Scholar and search for pdfs of your topic. Type in your topic and include pdf in the search term. You should get a listing of entries that look like this:



Click on the [PDF] link on the right side and not the article title. This will give you the full article rather than a link that may require you to pay for the article. If it does not give you the full article, do NOT use it as one of your sources.

--Encyclopedia entries, including computer and Internet encyclopedia sites, may be used as extra background info, but **do not** count towards the six source minimum. **Never use Wikipedia as a source!**

2. When you have located your sources, print out the articles.

3. Read the sources, highlighting with a highlighter pen the following information:
   a) Title of article or information
   b) Author
   c) Hypotheses used
   d) Focus of article or experiments
   e) Control and experimental groups
   f) Procedure
   g) Results
   h) Category of research (this is something you will have to determine and add – it will not be something you can highlight in the article

4. Don't forget to include **complete** bibliographic data for the source.
A complete bibliographic data entry is structured as follows:
Author(s); article title; journal name; volume and issue; month and year; page range;
and Internet address if accessed online.

5. Hand in all highlighted copies by specified due date.

USE OF REFERENCE MATERIALS
THE BACKGROUND LITERATURE SUMMARY

Library research is a very important component of scientific investigation. The investigator should be familiar with experiments done previously, related to his/her field. This background knowledge could lend new insight to the scientist's current course of investigation. A journal search and background literature summary is an important and valuable method to accomplish this background research.

Scientific journals are magazines written for the scientific community. They contain basic facts, data, and conclusions without any unnecessary commentary. In this assignment, you will be doing a background literature summary of journal articles. Do not use magazine sources written for the general public, because the content is watered down and contains little helpful data. Using the resources at IUSB, Notre Dame, and Saint Mary's, or the Internet, complete the following:

1. List at least six (6) specific keywords used in your journal search. (These can be the same ones you used for your proposal and your Literature Search.)
2. Find a **minimum total of six (6)** reference articles from the various possible sources. (Sources include the various CD-ROM programs or reference catalog systems at the Universities, the computer reference system in our library, and the Internet. Google Scholar is a great resource.)
3. Photocopy or print the articles, making sure to correctly identify each journal or Internet source.
4. Read the articles and highlight important information with a highlighter pen. (Do **not** simply underline.)
5. Write an annotation (short summary) of each article, beginning with a proper bibliographical entry for the source (see page 38.) This annotation should include all major points, and should be one (1) to two (2) paragraphs long. (A paragraph contains five (5) sentences.) Do **not** attempt to copy the summary provided by either the long form of an Internet search or the article itself.
6. Attach the annotation to the Photocopied or printed article and turn in all six (6) by the specified due date.

THE PROJECT DATA BOOK

The Project Data Book is a journal of your progress through your Science Research Project. It is an accurate record of your data collection, including timelines, notes and photographs. The Project Data Book may be a notebook or binder, but must be bound in some way. Perhaps the best method would be a 3-ring binder with loose-leaf paper. That way, more paper can be added as needed. You can either attach photographs to paper (glue, tape, or staple), or add pages from a photograph album to hold the pictures.

Requirements for the Project Data Book

1. The first page should be the signed and approved copy of your topic proposal form.
2. Next, include a timeline page, which clearly defines your start date and completion date. This timeline should give an approximation of when you will perform each segment of your research project.
3. You should include an observation entry about your research project for a **minimum of once every other day.**
   --Make sure your entries are complete descriptions with commentary. ("No change" is **not** an acceptable entry.)
   --Date each entry.
4. Include at least one photograph of your project in progress once every two weeks. To avoid extra costs in developing film, you may include a signed note from a parent or supervisor that confirms you have taken a picture.
5. Project Data Books will be checked periodically for a grade of 20 points. You should have a minimum of seven (7) entries (one every other day) valued at two (2) points each, and one (1) photograph (or signature) valued at six (6) points.
   --You may include extra observations or photographs, background research, possible sources of error, completed surveys or questionnaires, or anything else that may be assigned by your individual teacher.
6. The entire Project Data Book will be turned in with your final project.

THE BACKGROUND RESEARCH PAPER

The purpose of a background research paper is to present background information related to your research project. This information could include explanatory narratives of techniques and equipment, general information that enhances your topic, and/or other related research experiments that have been performed in the past.

REQUIREMENTS:

1. This paper should be three (3) to five (5) pages, typed.
2. You should double-space, and use standard margins and indentations.
3. Use 12 point type, and choose from the following fonts: Helvetica, Times New Roman, Courier New.
4. Always write in third person.
5. Do not include any description of your own current experiment. That is not the purpose of this paper.
6. Cite **ALL** references. You should have a Citation page of at least six (6) reference sources, excluding encyclopedias. It would be assumed that your paper should include at least eight (8) to ten (10) references to these sources.
7. Cover pages are optional.
8. This paper will eventually become the Introduction of your final paper. Keep this in mind when you write it. Save this paper to a disk for future use.
9. Proofread your paper. Twice. Have two (2) other people proofread it as well. You will be glad you did.
10. See the section of the Research Guide on Writing the Research Paper for more information.
11. Hand in two (2) copies of this paper on the specified due date.

APPENDIX B

REQUIRED FORMS

REQUIRED FORMS FOR PRE-COLLEGE RESEARCH

The forms required by National Science Service for all Pre-College level Science Research can be found, filled in and downloaded at the following web address:
https://www.societyforscience.org/isef/forms/
(This link may not work. You may need to type the address in manually.)

APPENDIX C

Grade Guides

SCIENCE PROJECT POSTER GRADE GUIDE

Name _____

1. Title _____/5 points

2. Problem _____/5 points

3. Hypothesis _____/5 points

4. Procedure _____/10 points

5. Data
   3 Pictures _____/10 points
   Graph/Chart/Table _____/5 points

6. Results _____/5 points

7. Discussion _____/5 points

8. Conclusions/Future Action _____/10 points

9. Bibliography _____/5 points

10. Quality/Complexity _____/20 points

11. Neatness/Organization _____/10 points

12. Originality _____/5 points

Total Grade = _____/100 points possible

SCIENCE PROJECT QUAD POSTER GRADE GUIDE

Name _____

A. Title _____/5 points

B. Quad 1

1. Problem _____/5 points
2. Hypothesis _____/5 points
3. Introduction _____/5 points

C. Quad 2

1 Procedure _____/5 points

C. Quad 3

1. Data
   3 Pictures w/captions & references _____/15 points
2. Graph/Chart/Table _____/10 points

D. Quad 4

1. Discussion _____/5 points
2. Conclusions/Future Action _____/5 points

E. Bibliography _____/5 points

F. Quality/Complexity _____/20 points

G. Neatness/Organization _____/10 points

H. Originality _____/5 points

Total Grade = _____/100 points possible

Total Points Earned: _____
Total Points Possible: 250
Name _____
Category of Research _____
Period _____

Science Research Project

TITLE _____

1. **Design** – Subtotal **30** pts. **Total: _____**

   a. Neatness: _____ out of 5

   b. Typing: _____ out of 5

   c. Organization: _____ out of 5

   d. Clear Labels: _____ out of 5

   e. Visuals: _____ out of 5
   -includes photos, drawings, diagrams, mattes, etc.

   f. Construction: _____ out of 5

2. **Experimentation Verification** – Subtotal **30** pts. **Total: _____**
   Photographs from duration of project showing progress as well as distinct experimental and control groups. A minimum of six (6) photographs is required. Additionally, projects involving surveys of questionnaires must provide **all** surveys or questionnaires, as well as permission forms.

3. **Data/Report** – Subtotal **100** pts. **Total: _____**

a. Title: _____ out of 5

b. Problem: _____ out of 5

c. Hypothesis: _____ out of 5

d. Procedure: _____ out of 10

e. Data: _____ out of 20
-Data must be presented in a quantitative manner.

f. Statistics/Central Tendencies: _____out of 10

g. Abstract: _____ out of 10

h. Results: _____ out of 10

i. Discussion: _____ out of 10

j. Conclusions: _____ out of 10

k. Bibliography: _____ out of 5

4. **Quality** – Subtotal **90** pts. **Total: _____**

a. Scientific Thought/Complexity: _____out of 50

b. Creativity: _____ out of 30

c. Sources of Error: _____ out of 10

Science Research Paper Evaluation Form

Name _____

I. Format and Content

A. Title Page

1. Title of Research _____/1
2. Name _____/1
3. Course Info _____/1

B. Numeration _____/1

C. Abstract

1. Heading _____/2
2. Format _____/2
3. Content _____/2

D. Introduction

1. Content _____/10
2. Use of References _____/10
3. Correct Reference Format _____/5

E. Problem _____/5

F. Hypothesis _____/5

G. Procedure _____/10

H. Data _____/5

I. Results _____/5

J. Statistics _____/5

K. Discussion _____/5

L. Conclusions _____/5

M. Works Cited

1. Format of entries _____/10
2. MLA style _____/5
3. Minimum number of References _____/5

TOTAL _____/100

II. Grammar, Punctuation, Spelling, etc.

Number of errors = _____ divided by 3 = _____

TOTAL (subtracted from 100) _____/100

FINAL GRADE =TOTAL I. and TOTAL II. averaged _____/100

Science Project Checklist

	Item	Due Date
1	Topic Proposal	
2	Background Literature Summary	
3	Literature Search	
4	Research Plan/Additional Forms/Checklist	
5	Problem	
6	Hypothesis	
7	Procedure	
8	Background Research Paper	
9	Research Grant Applications	Varies
10	Poster Presentation /Quad Chart	
11	Project Data Book	Checked periodically – due w/Final Project
12	Project	
13	Statistics/Tendencies	
14	Abstract	
15	Presentations	
16	Regional Science Fair Competition -- Those Chosen Projects	
17	Research Paper	
18	PowerPoint Presentation	

APPENDIX D

Abstract

Here is the website link to the Official Abstract Form that must be used for your project. You should be able to fill out everything directly on this linked form and then print it out.

https://sspcdn.blob.core.windows.net/files/Documents/SEP/ISEF/2025/Forms/2025-22-Categories.pdf

APPENDIX E

Engineering & Inventions Project Guide

A Guide for Engineering and Invention Projects

This guide is a series of questions to answer as you plan and execute your project. Links are provided to sections of the International Rules that are pertinent. Understanding that engineering design is iterative, it will be important to check back as your project develops to ensure adherence with the International Rules for your safety and anyone involved in your project.

Getting Started:

The planning stage of a project is often the most critical and time-extensive. It involves goals-setting, project ideation, brainstorming, prototyping, background research (a literature review and/or patent search for prior art), needs assessment, identifying a mentor or supervisor for the project and obtaining any approvals necessary if your project will be working with human participants or vertebrate animals.

Problem to solve
● What is the problem? Why do you think it is a problem?
● What expertise or supervision might you need to explore this problem?
● What is the need? * (If you survey individuals for a needs assessment, work with your school to establish an Institutional Review Board (IRB) as discussed in the ISEF Rule book on page 5 and review and approve the human participant study before you begin.)
● Do you have a potential solution in mind to address your problem or need?
● What is/are the potential benefits(s) or value in addressing this problem or need?

What are similar problems/questions to your own?
• How is your idea similar to other ideas? How are they different?
• What comparisons could you draw?
• What could you learn from similar problems/solutions?

Is your idea novel (new)?
• Does it have utility or function?
• Is it a solution that is “obvious”?
• How can you make it your own?

Have you conducted a patent search?

Design/Methods

Determining the answers to these design/methods questions will help determine additional risk assessments, rules review, supervision required and any pre-review and approval requirements before the experimentation/building phase can begin.

What
● What is your approach? How are you going to solve the problem or address the need? How are you going to answer the question?
    o Will you be building a prototype?

- ▪ Do you have an existing model to work from?
- ▪ Are there standard criteria that you need to be aware of?

o Will you be collecting data?

- ▪ How are you going to collect the data?
- ▪ How can you control variables?
- ▪ Do you need to build something to collect the data?

o Are you going to conduct experiments?

- ▪ How many trials will you need to do?
- ▪ What are elements of the prototype that will need to be tested?
- ▪ How can you tell if it works?

With What Materials?

Material selection is an important element of risk assessment as it may involve hazardous substances or devices that have requirements regarding usage and supervision. Material selection also involves considering environmental concerns as well as those of cost and replicability.

• What are the materials that you will be using?

o How easy is it to obtain the materials?

•What are the costs of the materials?

o What hazards are associated with the materials? (hazard identification/assessment)

▪ How do you determine the potential hazards of your materials? (SDS sheet, hazard information databases)

- ▪ Are there human or mammalian health hazards?
- ▪ Are there aquatic hazards?
- ▪ Are there environmental or ecosystem hazards? (i.e., ozone depleting potential, global warming potential, etc.)

o What is the potential for exposure to the hazard? (risk assessment)

- ▪ Hazards x Exposure = Risk
- ▪ What personal protective equipment (PPE) (if any) is required for the materials?

o What alternatives might you consider? (alternatives assessment)

o Consider the lifecycle of the materials:

▪ Starting material/Raw materials: Are your materials from renewable or depleting feedstocks? (i.e., biobased versus petroleum)

▪ Process: Are there high energy requirements as part of the process? Are there hazardous materials/chemicals used in the process?

▪ Product: Are there hazards associated with the final product? ▪ End-of-life: Is there waste produced? What happens to the products after use? How will you dispose of unused materials?

- ● What is the appropriate/required waste disposal method(s) for the waste?
- ● How will unused materials be disposed? (i.e., reused, recycled, biodegraded (composted), disposed)
- ● How will the product be disposed of after use? (i.e., reused, recycled, biodegraded (composted), disposed)

Where

The setting of your experimentation (Home, School, Regulated Research Institution, etc.) is an important consideration influenced by the nature of the study, the supervision needed and in some cases the equipment and/or biosafety-level containment available.

- Where do you plan to conduct your research?
- What requirements or constraints exist for where you can operate?
- What equipment will you need?
    - o What locations have the equipment for you to use?
    - o Do you have permission and proper training to use the needed equipment?
    - o What supervision is required (if any).
- What environmental conditions do you need?
    - o Do you need to be in a laboratory environment that has the necessary biosafety features and equipment? (BSL-1 or BSL-2)
    - o Do you need to have a climate-controlled space?
    - o Will your project require being outdoors to allow room (no ceilings or limited space)?

How are you going to test or draw conclusions about your solution/answer?

- Will you be testing your device?
- How many trials you will need to conduct?
    - o Have you determined what will need to be measured to confirm that the product solves the problem?
    - o Are there multiple measures or elements to consider?

Human Participants - How will humans interact with your product?

Please review all Human Participant rules and the role of an Institutional Review Board (IRB) as discussed on page 5 of the International Rules.

- What safety features and/or instructions will you need to consider so that people use the product safely and for its intended purpose?
- Will you have others (classmates, friends, family, human participants) testing your device?
- Do you need to conduct a survey or questionnaire to get opinions of others?
- Have you considered alternative methods of testing without human participants?

Vertebrate Animals - Does your project involve using animals or testing on animals?

Please consult the Vertebrate Animal section of the International Rules and have review by the Scientific Review Committee (SRC) prior to working with vertebrate animals.

- If yes, have you considered alternatives?
- If working with animals, you will need to consider
    - o Where do you obtain the animals?
    - o How do you protect the health and well-being of the animals being used?
    - o Who will be caring for the animals while they are involved in the project?
    - o Have you consulted a Veterinarian?
- What risks are involved to the animals or the student researcher working with the animals
    - o Have you gotten the necessary permissions, permits or approvals to work with the animals?
    - o What happens to the animals after the project is concluded?

ENGINEERING AND INVENTION PROJECTS GUIDE

USE THIS INFORMATION TO HELP DETERMINE THE REQUIREMENTS OF ENGINEERING PROJECTS AND POTENTIAL AREAS THAT WILL REQUIRE PRE-APPROVAL AND/OR EXTRA SAFETY PRECAUTIONS.
A GUIDE FOR ENGINEERING & INVENTION PROJECTS HAS BEEN DEVELOPED AS AN ADDITIONAL RESOURCE AND PROVIDES A SERIES OF QUESTIONS TO CONSIDER AS YOU BEGIN AND DESIGN AN ENGINEERING OR INVENTION PROJECT.

ENGINEERING AND INVENTION PROJECT CHECKLIST

Consider the answers to the questions below. If the response is yes, then the project may fall under more specific rules and those sections of the International Rules & Guidelines should be consulted.

Hazardous Chemicals, Activities and Devices
Will your project involve any of the following:
□ DEA-controlled Substances
□ Firearms and Explosives
□ Prescription Drugs
□ Alcohol & Tobacco
□ Regulated Drones
□ Radiation

If any are checked, see Hazardous Rules, page 22.

Device Testing with Human Participants
□ Are you going to test your project (device, app, invention, prototype, etc.)? If yes, does it require persons to interact with it other than yourself or adult sponsor/supervisor?
□ Do you intend to gather background knowledge through a survey or interviews to understand the potential use and needs for your project design?
□ Are you going to ask for opinions or suggestions on your project design at any point of the project?
□ Does your project intend to gather personal data/have a health benefit to the user?

If any are checked, see Human Participant Rules, page 6.

Vertebrate Animals
□ Does your project include any interaction with vertebrate animals in any phase of the project?

If any are checked, see Vertebrate Animal Rules, page 11.

Potentially Hazardous Biological Agents
□ Does your project include any collection, examination or handling of microorganisms, and/or fresh or frozen tissue, primary cell cultures, blood, blood products or body fluids?
□ Are you going to culture or isolate any substance, known or unknown?

If any are checked, see Potentially Hazardous Biological Agents Rules, page 16.