# STEP 1: PROJECT PROPOSAL

The first step that you will be faced with is the project proposal. A well-designed project must follow all International Science and Engineering Fair (ISEF) rules. These rules may be found at https://student.societyforscience.org/international-rules-pre-college-science-research. The science fair is guided by rules that protect you from dangers, including safety, as well as protection from legal action. We may think that any project is acceptable. Be very careful to follow all rules, especially if you are completing a project with human subjects, microorganisms, or vertebrate animals. Before you begin your project you must complete all forms and signatures. A well-planned project will work smoother in the long run. Take the time to evaluate each step. Enjoy, have fun, and impress yourself with the best project that you have ever completed. See project resources at https://www.societyforscience.org/isef/international-rules/ Additional tips on methodologies can be found on TCRSF's Links page at https://www.tcrsf.net/Links.aspx

For many science fair projects, the most difficult task is getting started. As you prepare yourself for this amazing journey; there are a few things that must take place before we begin. To begin, you must have a topic for your project. The research project plan, as described by ISEF, is the development of a scientific research project involving several sets of data and experiments. A good project should contain a controlled experiment with as many trials as can be accomplished. A good statistical test usually requires 30 tests for best results. A MINIMUM OF 3 TRIALS IS MANDATORY FOR ALL PROJECTS. You will find a variety of sources in most libraries that will get you started on possible topics. Remember these are projects that have already been accomplished and you may need to take the idea or procedure and modify it into a new and unique project.

Here are a few suggestions for selecting a topic:

a. Talk with your parents, friends, teachers, or those in the scientific community about your ideas. Discuss time limits (all data should be completed by January 1), budget limits, and possible outcomes of the project.
b. Choose a lab topic that interests you. Look for something you are curious about. You will be spending months on this project, it should be something you consider fun and challenging.
c. Choose a topic which is feasible. Be sure it is at your level. Don't choose a college level project, you will be overwhelmed. Don't choose a very basic project because you think it will be easy to do. These projects end up requiring a lot more time and energy trying to create more things to do to get it up to your level. Work with materials that you have access to utilize. Projects with humans and vertebrate animals will take a considerable amount of time and energy to get everything approved and all forms completed. Choose wisely!
d. Try to narrow your topic without making it too difficult to find sources. You will want to find 10-15 sources to have an effective

project. For example, cancer is a very broad topic which could be narrowed down to treatment of bone cancer.

e. Don't try to design your experiment completely at this time. Allow your topic ideas to develop as you conduct your literature search on your topic. Your sources will help you develop a well designed controlled experiment as you collect notes on your topic. Don't limit yourself at this time.

f. Incorporate your topic ideas into the scientific process: 1) observation, 2) ask questions, 3) form a hypothesis, 4) experiment, 5) gather and record results/data, and 6) conclusion. Will your topic fit into this framework?

g. The following categories represent areas from which you may develop topic ideas:

Animal Sciences
Behavioral and Social Sciences
Biochemistry
Biomedical and Health Sciences
Biomedical Engineering
Cellular and Molecular Biology
Chemistry
Computational Biology & Bioinformatics
Earth and Environmental Sciences
Embedded Systems
Energy: Sustainable Materials & Design
Engineering Mechanics
Environmental Engineering
Materials Science
Mathematics
Microbiology
Physics & Astronomy
Plant Sciences
Robotics & Intelligent Machines
Systems Software
Translational Medical Sciences

Once you have settled in on a category you need to bring your focus to a specific problem to solve. ISEF also includes subcategories that fit under each of the above categories. These may aid in narrowing your topic. ISEF categories and subcategories are listed at https://www.societyforscience.org/isef/categories-and-subcategories/ . A well-defined problem will help you to focus your project, define the data to be collected, and speed up the process of implementing your experimental plan.

Scientific research will deepen your understanding of a subject through problem solving. By applying the processes and procedures of scientific research to your project, not only are you immersed in an interesting project, the results may yield benefits to all humans.

## Assignment 1: DEFINE PROBLEM

The most frequent question asked by a judge at a science fair is, “Why did you do this project?”. Before you begin a project you will want to address this question. Why are you doing a project? Why is it important to you, your school, the scientific community, or society?

To define the problem, you begin by asking to whom is the problem a problem. Who owns the problem? Who are the stakeholders that are directly involved with the problem? Who or what is being acted upon? Who or what would benefit from improvement in the problem? How you define the problem will affect what you decide

to research. For example, let's say you wanted to test the effects of seed type on growth in your garden. The following is one example for defining this problem:

WHO? The producers (farmer or home gardener)
STAKEHOLDERS? Farmers, gardeners, chemical company that produced the seed, seed company, salespeople, state or federal regulatory agencies, advisors (county extension agent, consultants)
ACTED UPON? Seed Types, Soil Conditions, and Growth Conditions
BENEFITS? Farmer or home gardener, consumers of the products, profits for company, environment

Knowledge of who is involved and why your project is important will help you understand more about why this project is important to society. A judge needs to know that you understand why you did this project and why it is important to you. A project that shows an important application in your life will be more successful than a project assigned as a classroom project. Seek out a project that will hold your interest throughout the six to nine months that you will work with this topic. Don't hesitate to ask your teacher or parents for help if you can't seem to get started.

The following worksheet will help you to define your problem as you begin to explore the importance of this project. A copy of this worksheet can be found on the CD at the back of this book.

DEFINE THE PROBLEM

Name_____
Topic of Interest_____
Lab/Class Number _____
Category_____

1. Define or explain the potential problem that you want to solve this year.
2. Who or what are the stakeholders that are involved with this project.
3. Why is this project important for you? the community? mankind?
4. List all practical applications of real life for this project.
5. Why do you want to do this project?

ASSIGNMENT 1

1. Complete the Define the Problem Handout.

## Assignment 2: FORMS

Forms are probably the most frustrating part of the science fair project. They can be a lot of work, however if they are completed before the project begins, most problems can be avoided. The best place to begin the forms is to use the Rules Wizard at https://ruleswizard.societyforscience.org/. This will identify which forms are necessary for your project. These forms help to document your project, which will ensure safety for you and the subjects along the way. Although these seem very tedious to complete, it is essential that they all are on file with proper signatures BEFORE you begin experimentation.

TCRSF recommends that you email your complete research plan to src@tcrsf.net with your name, school, and grade in school in case we require more documentation or proof of supervision than your school requires. This is done by the completion of Assignments 1-5, near the end of Step 1.

All projects must complete forms 1A and 1B. These are approval forms and all required signatures before starting your project. Your teacher will be the Adult Sponsor and will complete the Adult Sponsor and Safety Form. Other projects may require additional forms, such as working in another lab or dealing with humans, microorganisms, or vertebrate animals. Your teacher will provide you with current form copies to complete, or you can go online to https://www.societyforscience.org/isef/international-rules/ . These forms can be completed on-line and printed for your teacher. Be sure you are using the current year forms (DO NOT COPY FORMS FROM AN OUTDATED BOOKLET!) - Forms MUST BE SINGLE SIDED ONLY. Do NOT print on both sides. Use only white paper for printing. No colored paper! **(Preferably fill out your forms on TCRSF website to avoid having to do these forms twice!)**

Although your teacher does not want to limit your topic choice, previous experience has shown that human projects, microbiology projects, and vertebrate animal projects require a lot of extra effort on your part to get all forms completed. These usually involve prior approval before beginning your experimentation. Although this should not keep you from a project, you must address all other possible projects that could be completed without the use of humans or vertebrate animals. Seriously consider using an invertebrate animal for test subjects.

You probably are already overwhelmed with requirements. The process is very time consuming. You should plan on spending 2-5 hours a week if you plan on completing an excellent project. It will take a lot of hard work and perseverance to complete the project. Stick with it. Stay disciplined and get your work in on time. Your teacher can be an excellent help for you. YOU must, however, get your work turned in on due dates for teacher comments to help you out.

ASSIGNMENT 2
1. Complete Form 1A, 1B, and other forms as needed.

## Assignment 3: HYPOTHESIS

BEFORE you begin work on your project, you must create at least one hypothesis. You may find that your project does involve three or more alternative hypotheses. You will need to prioritize these hypotheses to determine your plan of attack for addressing these hypotheses. Scientific knowledge is obtained through the process of developing an idea, hypothesis, experimental plan, and then developing conclusions based on these results. Scientists use deductive reasoning to process an idea. This is based on previous knowledge that the learner has already acquired. You will find an informative chapter of ideas on how we acquire knowledge in Anton E. Lawson's book, *Biology: A Critical-Thinking Approach* (Lawson, 1996). Although this is written in a biology viewpoint, it can be used across the sciences to understand how scientists solve problems. As you read this, think about how your hypothesis fits with your previous knowledge base and your experimental plan.

The hypothesis is more than simply an educated guess as most books like to address it. The hypothesis is an idea or prediction which you see as the best possible solution to your problem. Keep in mind that the hypothesis must be capable of being tested. When writing the hypothesis, try to limit it to four or five sentences. A clear and concisely written hypothesis will tell the reader what it is you think will be the solution to the problem being tested.

ASSIGNMENT 3

1. Develop a clear hypothesis that is based on all previous knowledge and fits into your experimental plan.

## Assignment 4: EXPERIMENTAL DESIGN

Now that you have a preliminary hypothesis, you are ready to begin the process of designing your experiment. The main focus of this chapter will be exploring the basic procedures that you want to accomplish. Remember this is only a plan. It may change as you continue to progress through the project. This plan will be used by the scientific review committee to approve your work before you begin. Be sure to give enough detail so that someone else could repeat your work. Realize that if your plan changes, you will need to have it reevaluated by the review committee. This may lead to a three to four week delay. It is very important to do the planning work up front to avoid changes.

You may find it helpful to look in various books to help you understand the experimental design process. One of the best sources is Students and Research by Julia H. Cothron (Cothron, et al., 1989). You may find many other sources in the teacher's classroom or a local library.

You should include the following ideas in your plan: variables, treatments, controls, experimental procedures and replications, plans for data collection, methods of data analysis, and necessary materials and equipment needed to complete this project. You should also include a brief timeline, which outlines the timeframe for experimentation. Adequate time must be saved for data analysis and presentation preparation. Begin experimentation as soon as you have approval. DO NOT WAIT TO SET UP YOUR EXPERIMENT BECAUSE YOU THINK IT CAN BE DONE IN TWO DAYS! You may encounter many challenges that could delay your project.

You should continue to turn in journal sheets for each day that you work on your project. Judges want to know that this is your work, and the journal verifies each day that you work on your project.

The experimental design plan sheet will ask that you complete the following parts:

1) Title: The title should concisely describe your project. It should catch the reader's attention and show what the project is about. The best project titles are between 8-10 words in length.

2) Independent Variable: This variable is the one which you are using to test your hypothesis. This is what you, as the scientist, are manipulating in the experiment.

3) Dependent Variable: This is the variable that you are measuring as data in your experiment. This variable is dependent upon what the independent variable is causing in the experiment. This is the information that you are going to use to try to analyze the effect that your independent variable had on the experiment.

4) Control: The control is a group of identical constants set up to compare to the independent variable(s). YOU MUST HAVE A CONTROL TO MAKE ANY VALID CONCLUSIONS OR COMPARISONS OF THE DATA COLLECTED!

5) Constants: These are everything that is kept the same in both the experimental and control group settings. The more constants that you control in your experiment the easier it will be to analyze your data and come up with valid conclusions. A common error in science fair projects is when these are not identified.

6) Repeated Trials: Every experimental design requires more than one trial for reducing possible errors in your experimental design. The number of trials will depend upon the availability of subjects, cost of materials, and ease of collecting data. A MINIMUM OF THREE TRIALS MUST BE COMPLETED FOR ALL PROJECTS. Statisticians recommend 30 trials for good statistical evidence when using analysis such as the T-Test.

7) Procedure: The procedure describes what you plan to do with the project. Remember this is only a plan, and things may change. Theoretically, another scientist should be able to duplicate your work by following this procedure.

8) Materials Needed: A detailed list of materials needed will help you to get organized before you begin your research project. It will also allow your teacher to see what equipment the school may have to help you with your project. Be as specific as possible here, as this will save you a lot of time later in the project.

   You will find a variety of sample experimental plans and ideas in the classroom. Once again, don't hesitate to ask for assistance from your teacher or parents. A well-designed experiment will run much smoother in the later steps.

ASSIGNMENT 4: Experimental Plan

1. Complete experimental design sheet.

EXPERIMENTAL DESIGN PLAN SHEET Name_____

Project Title:

_____

_____

Independent Variable:_____

Dependent Variable:_____

Control(s):_____

Constant(s):_____

_____

Repeated Trials:_____

Procedures:

Materials Needed:

## Assignment 5: Key Sources

The final step in the project proposal is to locate at least five key sources that you will use to find background information about your project. These should be primary authoritative sources. This means the source should contain original data or information that is verifiable in a scientific way. These could include books, magazines, scientific journals, interviews, or abstracts. You should avoid internet websites, unless you can verify the credibility of the source. Beware of fake internet sources that look like scientific research. Usually, most internet sources from educational sources (www.???.edu) or government sources (www.???.gov) are credible. A good scientific search engine or database may be a good starting place. When you find a source, be sure to copy all necessary information needed to find the source again or to document in your paper. We will discuss proper format for sources at a later time. Be sure to include the date you accessed the information on a website source since websites can change but your date accessed states that the information you used was available on the date that you accessed the website.

You have now completed all work for step 1. You should turn in all forms and the research plan attachment. This will be your project proposal. Be sure to type this work so that it may be reviewed by other scientists. Their input may save you many hours of frustration at a later time.

Be sure to keep yourself organized. Save all work on your computer as well as a storage device. Keep a backup in case something happens. As you continue to put your project together you will need every step from the process. DO NOT waste your time retyping earlier work. When we get down to "Crunch Time" your organization will be very helpful. Hang in there; put together a great project, and most of all HAVE FUN!

ASSIGNMENT 5

1. Develop a list of at least five key sources to be used in your project.
2. Include one source for care of animals if completing a project with animals.

# STEP 1 GRADE CRITERIA

E=Excellent S=Satisfactory N=Needs Work

The following grade criteria will be used to assign points for this assignment:

_____ problem defined

_____ forms completed as needed

_____ forms signed and dated properly

_____ hypothesis is concise, clearly stated, and testable

_____ experimental design plan sheet/procedures

_____ sources are primary authoritative

**Format** (Grammar, Spelling, Typed, Style) _____

**Content** (Information, Documented, Reliable, Journal) _____

**Creativity/Originality** (Ownership of Project, Ingenuity) _____

**EXCELLENT WORK: 28-30**
**SATISFACTORY WORK: 24-27**
**NEEDS IMPROVEMENT: 21-23**

**Total Points _____/30 points**

Suggestions for Improvement: