



INCORPORATING  
A COMPONENT ON  
Biomedical  
Research  
INTO YOUR  
Classroom



## Why is Biomedical Research important?

*If COVID has taught us anything, it is that scientists who work on the prevention and treatment of diseases are critically important for not only keeping the public safe and healthy, but also maintaining order in a society. Biomedical Research is the branch of science that helps the scientists come up with vaccines and medicines to help control a whole range of ailments from COVID to the common cold. It includes both physical and life sciences to study diseases and biological processes in order to develop effective treatments.*

## Careers in Biomedical Research

Careers for a biomedical scientist span a wide variety of fields from Science oriented Biotechnology, Laboratory Research, Toxicology, and Pharmaceuticals to affiliated fields such as Public Health, Regulatory Affairs and Patent law.

## NGSS and Biomedical Research

The *Next Generation Science Standards* (NGSS) emphasizes more student-centered learning that enables students to think on their own, problem solve, communicate, and collaborate. When students choose to work on a research project such as in Biomedical Research, it gives them an opportunity to do hands-on, collaborative work that often involves interdisciplinary areas of science rooted in inquiry and discovery. Look at the links on the last page to see a document that shows how a research class aligns with the NGSS.

## Animals and Plants in Biomedical Research

If an experiment can be done with plants instead of animals, students should always opt for that. With the advancement of technology, many investigations can be done through simulations using computer modeling techniques. While research using animals remains critical, only when other options are not available, students should take up research on animals.

Many have questions about animal testing ethics and the animal testing debate. There are several reasons why the use of animals is critical for biomedical research:

- Animals are biologically very similar to humans. In fact, mice share more than 98% DNA with us!
- Animals are susceptible to many of the same health problems as humans—cancer, diabetes, heart disease, COVID-19, etc.
- With a shorter life cycle than humans, animal models can be studied throughout their whole life span and across several generations, a critical element in understanding how a disease develops, progresses and how it interacts with a whole, living biological system.

Source: [med.stanford.edu/animalresearch/why-animal-research](https://med.stanford.edu/animalresearch/why-animal-research)





Nothing so far has been discovered that can be a substitute for the complex functions of a living, breathing, whole-organ system with pulmonary and other circulatory structures like those in humans. Until such a discovery occurs, animals must continue to play a critical role in helping researchers test potential new drugs and medical treatments for their effectiveness and safety, and in identifying any undesired or dangerous side effects, such as infertility, birth defects, liver damage, toxicity, or cancer-causing potential. Moreover, rodents (rats and mice) that are bred for laboratory use make up 95% of all animals used in biomedical research in the United States. It is also important to note that animals are only one part of the larger process of biomedical research.

In the use of animals there should be no mistreatment of them. All safety rules and animal welfare guidance needs to be followed. U.S. federal laws require that non-human animal research occur to show the safety and efficacy of new treatments before any human research will be allowed to be conducted. Not only do we humans benefit from this research and testing, but hundreds of drugs and treatments developed for human use are now routinely used in veterinary clinics as well, helping animals live longer, healthier lives.

Source: [calbioresearch.org/wp-content/uploads/2020/08/WhyAnimals.pdf](http://calbioresearch.org/wp-content/uploads/2020/08/WhyAnimals.pdf)

## Vertebrate animals and state guidelines in science fair projects

**Society for Science and the Public**, is a non-profit organization dedicated to the promotion of science, through its science education programs, publications and many national and international science competitions. It is recommended that students follow their rules for animal research so that if the project is selected to move forward to Regional, State and National level competitions, the work will not be disqualified for not following the safety rules.

The Society 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.

All vertebrate animal studies must have a research plan that includes:

1. Justification of why animals must be used.
2. Description of how the animals will be used.
3. Students performing vertebrate animal research must satisfy US federal law as well as local, county and state laws and regulations of the jurisdiction in which research is performed.
4. Research projects which cause more than momentary or slight pain or distress on the animal subjects are prohibited.
5. No vertebrate animal deaths due to the experimental procedures are permitted in any group or subgroup.
6. All animals must be monitored for signs of distress.

Not only should the students follow the rules, but their teachers also need to be informed on the proper use of animals in the laboratory. Look at the links on the last page for more detailed rules and regulations for projects involving animal research.

# High School Research Class Outline

## Expectations

Students are expected to work independently for at least 5 hours per week and maintain a detailed log book of their work. The course emphasizes the importance of writing, presentation, and oral communication to convey the intended message effectively. Students share their progress once a week via a PowerPoint or FlipGrid video. Once a month, an extended class meeting is organized after school for students to elaborate on their work.

## Timeline

A typical time line for the high school independent study Science Research Class is as follows:



### August–September

Student expectations are stated, maintaining a log book is stressed, the general course outline along with a regional science fair timeline is discussed, and the students are asked to brainstorm and choose a topic to study or a problem to solve.

### September–October

Students learn how to do literature search on websites like *Pubmed.gov* research the topic or what the problem is, what it is and what is currently being done about it

### October–November

Find a mentor/advisor to guide and help the students make contact with research labs; design a controlled experiment or project with step by step procedures; obtain Advisor approval; secure a lab or experiment location, and determine if pre-approval from the regional fair is necessary to conduct the experiment.

### November–December

Obtain pre-approval if necessary; order the materials and start the experiment under advisor supervision

### December–January

Students collect, tabulate and analyze data. Learn how to present data.

### January–February

Conduct a school level Science Fair for students to get feedback from mentors/judges and improve on the project

### February–March

Revise the project and get ready for the Regional Science Fair followed by other competitions like Skills USA and HOSA

### March–April–May

Prepare and participate in Regional, State, National, and International Competitions. Apply to the Southern California Academy of Sciences-Research Training Program for high school students (SCAS-RTP)

### April–May–June

Practice grant writing for Scientific Research. Choose appropriate institutions that provide grants in the specific area and submit the proposals.



## Resources

### Align with NGSS

[drive.google.com/file/d/1skX3JVePc1RacLkQOMa3LFYA49oy7OKl/view?usp=sharing](https://drive.google.com/file/d/1skX3JVePc1RacLkQOMa3LFYA49oy7OKl/view?usp=sharing)

### Biomedical Science

Careers: [calbioresearch.org/careers-in-biomedical-science](https://calbioresearch.org/careers-in-biomedical-science)

Facts: [ca-biomed.org/get-the-facts](https://ca-biomed.org/get-the-facts)

Curriculum Materials: [calbioresearch.org/curriculum-materials](https://calbioresearch.org/curriculum-materials)

### Student Project Samples

[drive.google.com/file/d/1eyAR5f1FaOvV3YkiQR7hhp3LYavhNoNj/view](https://drive.google.com/file/d/1eyAR5f1FaOvV3YkiQR7hhp3LYavhNoNj/view)

[drive.google.com/file/d/1-TTR22T5x5lGH0ApM\\_6j-TZFc2oWPD0v/view?usp=sharing](https://drive.google.com/file/d/1-TTR22T5x5lGH0ApM_6j-TZFc2oWPD0v/view?usp=sharing)

### Science Fair Links

#### Rules for Vertebrate Animals

[societyforscience.org/isef/international-rules/vertebrate-animals/#allrules](https://societyforscience.org/isef/international-rules/vertebrate-animals/#allrules)

#### Regional

[sciencebuddies.org/science-fair-projects/science-fair/science-fair-directory](https://sciencebuddies.org/science-fair-projects/science-fair/science-fair-directory)

#### State

California [csef.usc.edu/](https://csef.usc.edu/)

#### International

[societyforscience.org/isef/](https://societyforscience.org/isef/)

### High School Internships (not exhaustive)

[viterbik12.usc.edu/shine/overview](https://viterbik12.usc.edu/shine/overview)

[training.nih.gov/programs/hs-sip](https://training.nih.gov/programs/hs-sip)

[lundquist.org/hssfp](https://lundquist.org/hssfp)

[oak-crest.org/students/yes](https://oak-crest.org/students/yes)

[lanl.gov/careers/career-options/student-internships/high-school/index.php](https://lanl.gov/careers/career-options/student-internships/high-school/index.php)

[ugr.ue.ucsc.edu/Arthritis](https://ugr.ue.ucsc.edu/Arthritis)



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