Your Summer Research at FOMD

Think Boldly
Dream Big
Be Responsible
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Why would you spend your summer doing research?

- You want to see if you like it and if this is something that you want to do in the future
- You tried it before and got hooked!
- You needed a job
- You will be needing a letter of recommendation in the near future
YOU'VE BEEN SELECTED
What can you get from a Summer Research at FOMD?

- Deepen your understanding of science
- Enrich your perspective on scientific research
- Discover a passion to become a scholar or find your way to change the world

Whatever path you follow, you’ll have a learning experience that makes a true and lasting impact
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What is Scientific Research?
“Research is creating new knowledge.”

— Neil Armstrong (1930 – 2012)
American astronaut and first person to walk on the moon
“Research is to see what everybody else has seen, and to think what nobody else has thought.”

— Albert Szent-Gyorgyi (1893 – 1986)
Physiologist and Nobel Prize recipient
By doing scientific research you are going to learn **HOW SCIENCE REALLY WORKS**

Scientific Method (1 serving)

1. Ask a question.
2. Formulate a hypothesis.
3. Perform experiment.
4. Collect data.
5. Draw conclusions.

Bake until thoroughly cooked.
Garnish with additional observations.

http://undsci.berkeley.edu/article/howscienceworks_01
The Real Process of Science
There are many routes into the process of Science

http://undsci.berkeley.edu
Scientific testing is at the heart of the process

[Diagram showing the process of scientific testing]

http://www.understandingscience.org
The scientific community helps ensure science’s accuracy

http://www.understandingscience.org
The process of science is intertwined with society

http://www.understandingscience.org
The Process of Science is not pre-determined
core logic of science: testing ideas with evidence
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You are trying to answer an important scientific question.
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Your work will represent an important piece of the puzzle
What Can You Expect from your Summer Research?

I have no idea what's going to happen.

And I love it.
The summer research program will offer opportunities to:

- **Develop organizational skills**
  - Maintain a well-organized lab book
  - Plan the experiments in time and manner
  - Follow the plan as much as possible

- **Become technically competent at performing experiments**
  - Perform experiment in an accurate manner
  - Keep good records
You would learn how to deal with the unpredictability of science

Some days I don’t know what I am doing…… I am frustrated!!!
You would learn how to deal with the unpredictability of science.
With time you would develop original research ideas

Will I ever have my own research ideas?
You would become a critical thinker

- are curious
- reserve judging until they have all the facts
- formulate well-reasoned arguments
- ask relevant and pertinent questions
- are aware of their own biases
- are open to changing their opinions based on new information
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Number 1 Responsibility: HONESTY
It is important to keep in mind that...

- Our work is supported by the public
- Our research impacts the public
- The public should be able to understand what drives us, and how they have supported us to develop our research
Be Responsible when...

- **Planning and performing experiments**

  - Working with animals
    - the three Rs
      - **Replace** the use of animals with alternative techniques, or avoid the use of animals altogether
      - **Reduce** the number of animals used to a minimum
      - **Refine** make sure animals suffer as little as possible

  - Working with human patients, human samples or manage data from patients
    - **Confidentiality**
Be Responsible when....

- Communicating your results
  - Be mindful of the **knowledge gap** between the general public and scientists
  - Be mindful of the **gap** between public expectations and the reality of scientific progress toward clinical application
The general population has notably different views from those of the scientific community on key science-related issues.
An Opinion Gap Exists Between the General Public and Scientists on Science and Technology Topics

Opinion Differences Between Public and Scientists
% of U.S. adults and AAAS scientists saying each of the following

<table>
<thead>
<tr>
<th>Biomedical sciences</th>
<th>U.S. adults</th>
<th>AAAS scientists</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safe to eat genetically modified foods</td>
<td>37%</td>
<td>88%</td>
</tr>
<tr>
<td>Favor use of animals in research</td>
<td>47%</td>
<td>89%</td>
</tr>
<tr>
<td>Safe to eat foods grown with pesticides</td>
<td>28%</td>
<td>68%</td>
</tr>
<tr>
<td>Humans have evolved over time</td>
<td>65%</td>
<td>33%</td>
</tr>
<tr>
<td>Childhood vaccines such as MMR should be required</td>
<td>68%</td>
<td>18%</td>
</tr>
</tbody>
</table>
An Opinion Gap Exists Between the General Public and Scientists on Science and Technology Topics

### Climate, energy, space sciences

<table>
<thead>
<tr>
<th>Topic</th>
<th>General Public (%)</th>
<th>Scientists (%)</th>
<th>Gap</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate change is mostly due to human activity</td>
<td>50</td>
<td>87</td>
<td>37</td>
</tr>
<tr>
<td>Growing world population will be a major problem</td>
<td>59</td>
<td>82</td>
<td>23</td>
</tr>
<tr>
<td>Favor building more nuclear power plants</td>
<td>45</td>
<td>65</td>
<td>20</td>
</tr>
<tr>
<td>Favor more offshore drilling</td>
<td>32</td>
<td>52</td>
<td>20</td>
</tr>
<tr>
<td>Astronauts essential for future of U.S. space program</td>
<td>47</td>
<td>59</td>
<td>12</td>
</tr>
<tr>
<td>Favor increased use of bioengineered fuel</td>
<td>68</td>
<td>78</td>
<td>10</td>
</tr>
<tr>
<td>Favor increased use of fracking</td>
<td>31</td>
<td>39</td>
<td>18</td>
</tr>
<tr>
<td>Space station has been a good investment for U.S.</td>
<td>64</td>
<td>68</td>
<td>4</td>
</tr>
</tbody>
</table>


PEW RESEARCH CENTER

Antibiotic resistance

Knowledge and understanding of antibiotic resistance

91% say they have heard of the term “antibiotic resistance”

56% say they have a good understanding of what the term means

What do people understand by the term “antibiotic resistance”?

31% say it's the body becoming resistant to antibiotics

28% say it's antibiotics being less effective

20% say it's about overuse of antibiotics

https://blog.wellcome.ac.uk/2016/04/12/how-do-the-public-really-feel-about-science-and-research/
Gap between public expectations and scientific progress

- Innovative biomedical technologies are prone to “social bubbles”
  - Promotion of optimistic timelines often masks the slow progression of clinical applications and technologies within health systems
- There is a large gap between public expectations and clinical realities
Social Bubble: The Case of Stem Cells Research

- Stem cell (SC) therapies hold remarkable promise for many diseases

- Public expectations are fueled by intense media coverage and stakeholder arguments for research and public funding

Social Bubble: The Case of Stem Cells Research

Types of stem cells and where they come from:

1. **Tissue stem cells**
   - Tissue stem cells allow us to develop, grow, heal, and replace worn out cells.
   - Most tissues have tissue stem cells.
   - Muscle, Bone & Blood, Nervous system, Skin

2. **Embryonic stem cells**
   - These cells are created from the inner cell mass of a blastocyst.
   - Blastocyst (~150 cells, 200 micrometers)
   - Inner cell mass
   - Cells are collected, then grown on plates in a laboratory.

3. **iPS cells** (induced pluripotent stem cells)
   - Cells from a person are genetically reprogrammed in a laboratory.
   - The modified cells begin to gain the ability to self-renew and differentiate like embryonic stem cells can.
   - "embryonic-like" stem cells
Social Bubble: The Case of Stem Cells Research

13,249 newspaper articles

3,404 clinical trials

Social Bubble: The Case of Stem Cells Research

Newspaper articles focused disproportionately on neurological conditions, primarily, MS, stroke, PD, AD, spinal cord injury cardiovascular disease and diabetes.

Dissemination of Findings: The Case of Stem Cell Research

- Patients, desperately hope for life-altering therapies
- Patients are vulnerable to unscrupulous providers of unproven and expensive treatments
- There is a direct correlation between the numerous therapies for neurological conditions advertised by SC tourism clinic providers and media coverage

“Science is important for our democracy, for our economy. It can improve our health and quality of life, help solve the world’s problems of food security and energy, support sustainability, and drive economic growth. But to achieve this there needs to be a good relationship between science and society, based on trust in science and of scientists. This needs to be worked at because it cannot be taken for granted.”

— Sir Paul Nurse
Geneticist & Nobel Prize recipient