CRAFTING GREAT AIMS & OBJECTIVES

University of University of Connecticut
January 17, 2020

TODAY'S PRESENTER

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Grants Consultant

PhD, Physiology, University of Wisconsin-Madison

- >5 years as a grants consultant, helping clients develop grants over a broad spectrum of innovation—from robotics and software to applied physics, medical devices, and biomedical technologies—for agencies including the National Institutes of Health, National Science Foundation, Howard Hughs Medical Institute, United States Department of Agriculture, Department of Energy, and Department of Education.
- Joined the Hanover team in August of 2019.

LOGISTICS

- Presentation slated to last about 45-50 minutes
- Followed by time for Q&A
- Slides will be made available after today's presentation

TOPICS

INTRODUCTION TO THE GRANT-SEEKING LANDSCAPE

A GOOD IDEA VERSUS A FUNDABLE IDEA

AIMS VERSUS OBJECTIVES

A TESTABLE HYPOTHESIS

DEVELOPING GREAT AIMS

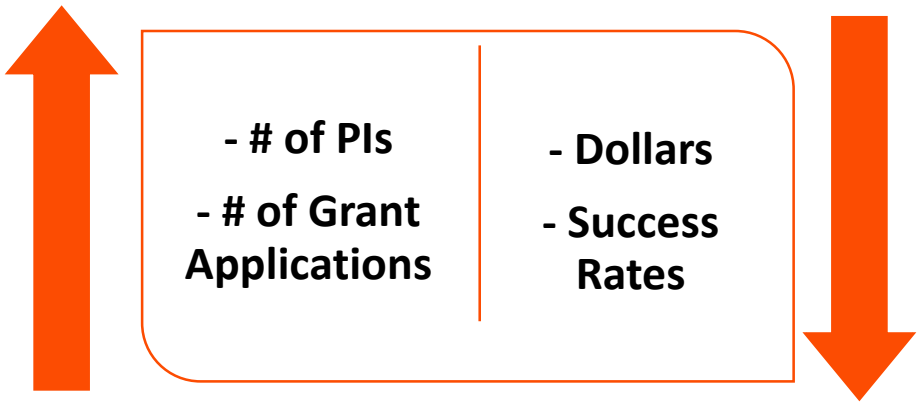
SPECIFIC AIMS: A CASE STUDY (NIH)

Q&A

THE GRANT-SEEKING LANDSCAPE

THE GRANT-SEEKING LANDSCAPE

- Hyper-competitive research environments
- Earlier research independence is challenging as early-stage faculty struggle to secure their first grant
- Mid- to late-stage faculty risk losing existing funding



Average age of investigators getting their first R01 is at an all-time high of 46 years old.

Source: Levitt M, Levitt J. "Future of fundamental discovery in US biomedical research". PNAS June 20, 2017. 114 (25) 6498-6503; published ahead of print June 5, 2017. https://doi.org/10.1073/pnas.1609996114

GOVERNMENT GRANTMAKERS

Agency strategic plans outline government funding priorities.

KEY FEDERAL GRANTS STATS

26

TOTAL FEDERAL GRANTMAKING AGENCIES

1,000+

TOTAL GRANT PROGRAMS ACROSS ALL AGENCIES

$961.4 Billion

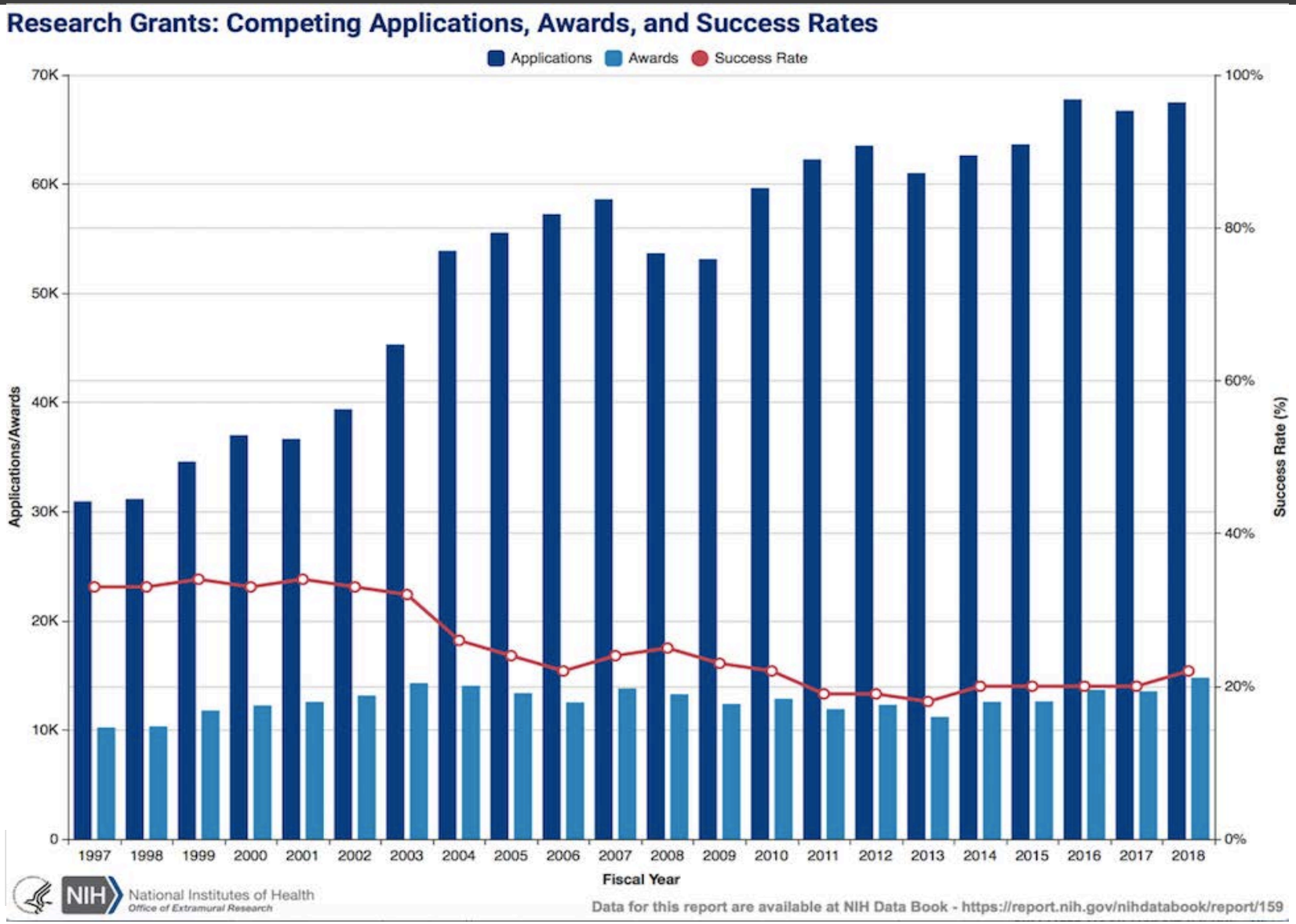
TOTAL FEDERAL OBLIGATED AMOUNT FOR GRANTS IN FY 2018

NATIONAL INSTITUTES OF HEALTH

NIH mission: ***To seek fundamental knowledge about the nature and behavior of living systems and the application of that knowledge to enhance health, lengthen life, and reduce illness and disability.***

- $39B annually in medical research for the American people.
- >80% of NIH funding is awarded through almost 50,000 competitive grants to >300,000 researchers at >2,500 institutions in every state and around the world.
- ~10% of the NIH budget supports projects conducted by ~6,000 scientists in its own laboratories, (mainly on NIH campus in Bethesda, MD).

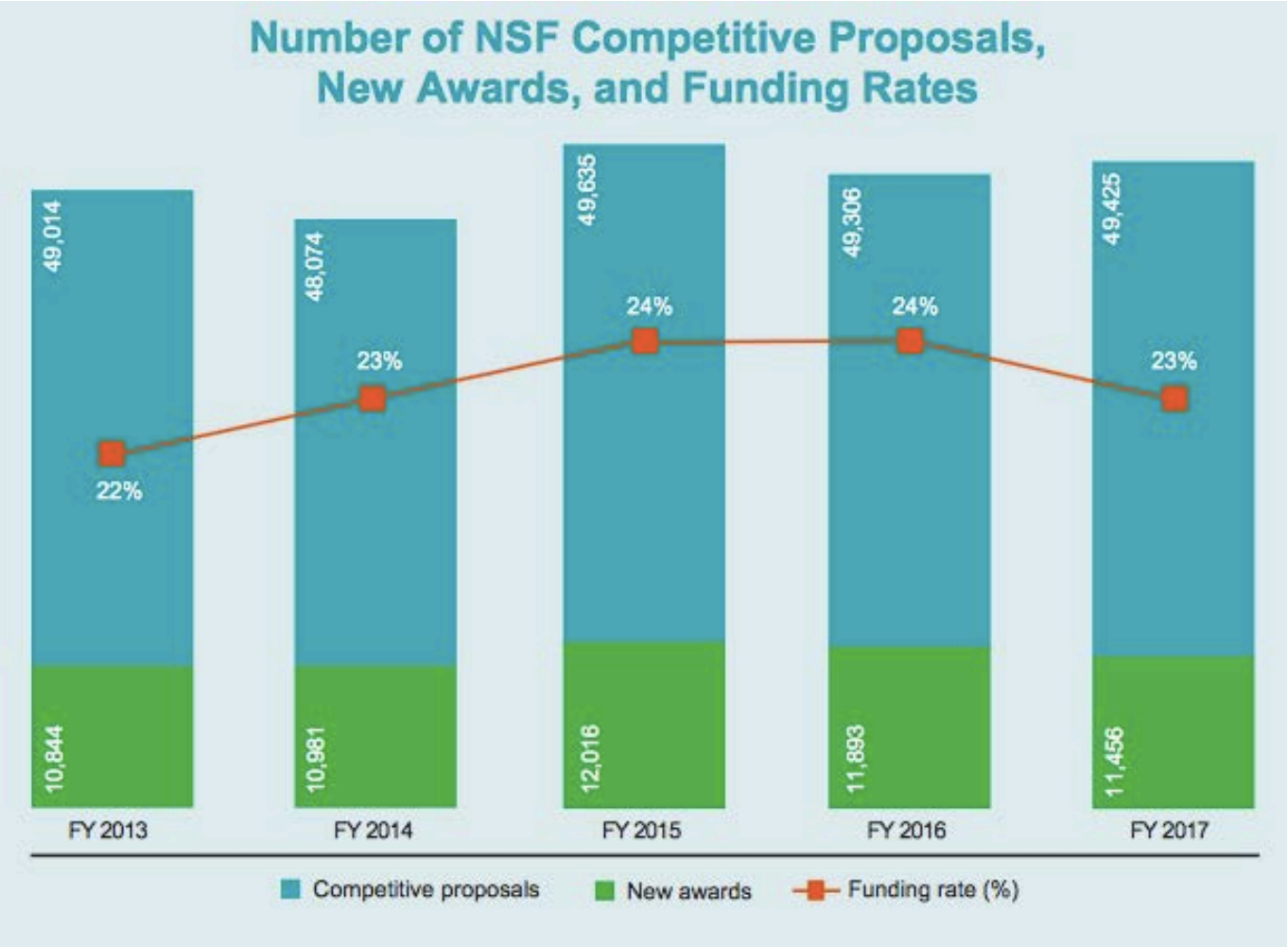
NIH DATA OVER THE YEARS



NATIONAL SCIENCE FOUNDATION

- $7B annual budget.
- Funds 24% of all federally supported basic research.
- Prohibited from funding clinical research.
- PO is much more involved in the review and funding process than POs at NIH—relationship is essential.
- Serve as a reviewer to see how the process compares to NIH and to see how best practices for applications differ.

COMPETITION IS STRONG: SNAPSHOT OF NSF



DEPARTMENT OF EDUCATION

ies INSTITUTE OF EDUCATION SCIENCES

The Department of Education is administered by the United States Secretary of Education. It has under 4,000 employees (2018) and an annual budget of **$68 billion** (2016).

The Institute of Education Sciences (IES) *intends to provide national leadership in expanding fundamental knowledge and understanding of (1) developmental and school readiness outcomes for infants and toddlers with or at risk for a disability, (2) education outcomes for all students from early childhood education through postsecondary and adult education, and (3) employment and wage outcomes when relevant (such as for students who engaged in career and technical, postsecondary, or adult education).*

DEFENSE AGENCY RESEARCH PROJECTS AGENCY

- $3.4B annual budget (FY2018).
- Broad range of interests that shift annually.
- Most programs require a pre-proposal.
- PO is much more involved in the review and funding process than POs at NIH/NSF—do not submit a full proposal if they don't like the pre-proposal. Often by invitation only.
- Apply early in the cycle to ensure the agency still has funds.

CONGRESSIONALLY DIRECTED MEDICAL RESEARCH PROGRAM (CDMRP)

- $14.7B annual budget.
- Catch-all for research in medical areas of interest to Congress.
- Major emphasis on applied research or research with clear clinical implications.
- Pre-application required in most cases.
- Some programs require or strongly encourage communication with a scientific contact prior to pre-application.


THE EVOLUTION OF A GREAT IDEA

A GOOD IDEA VS. A GRANT-FUNDABLE IDEA

A good idea:

- Helps someone
- Advances an important agenda
- Serves a wise/substantial purpose
- Creates interest
- Involves growth or learning
- Can have undefined steps or processes
- Builds something of value
- Has form that follows function
- Can be of any scale
- Can be a one-time effort

A fundable idea:

- Addresses the funder's target audience
- Advances the funder's agenda
- Serves a wise/substantial purpose
- Aligns with funder priorities
- Measures/analyzes growth and learning
- Must have a clear path from A > B > C (with limited exceptions)
- Builds something of value
- Fits in a pre-set spectrum of activity types
- Is scaled by prior experience and to the budget
- Should be replicable

For more information: Helping Faculty Differentiate Between the Good and the Fundable

USE OUTCOMES TO DRIVE DESIGN

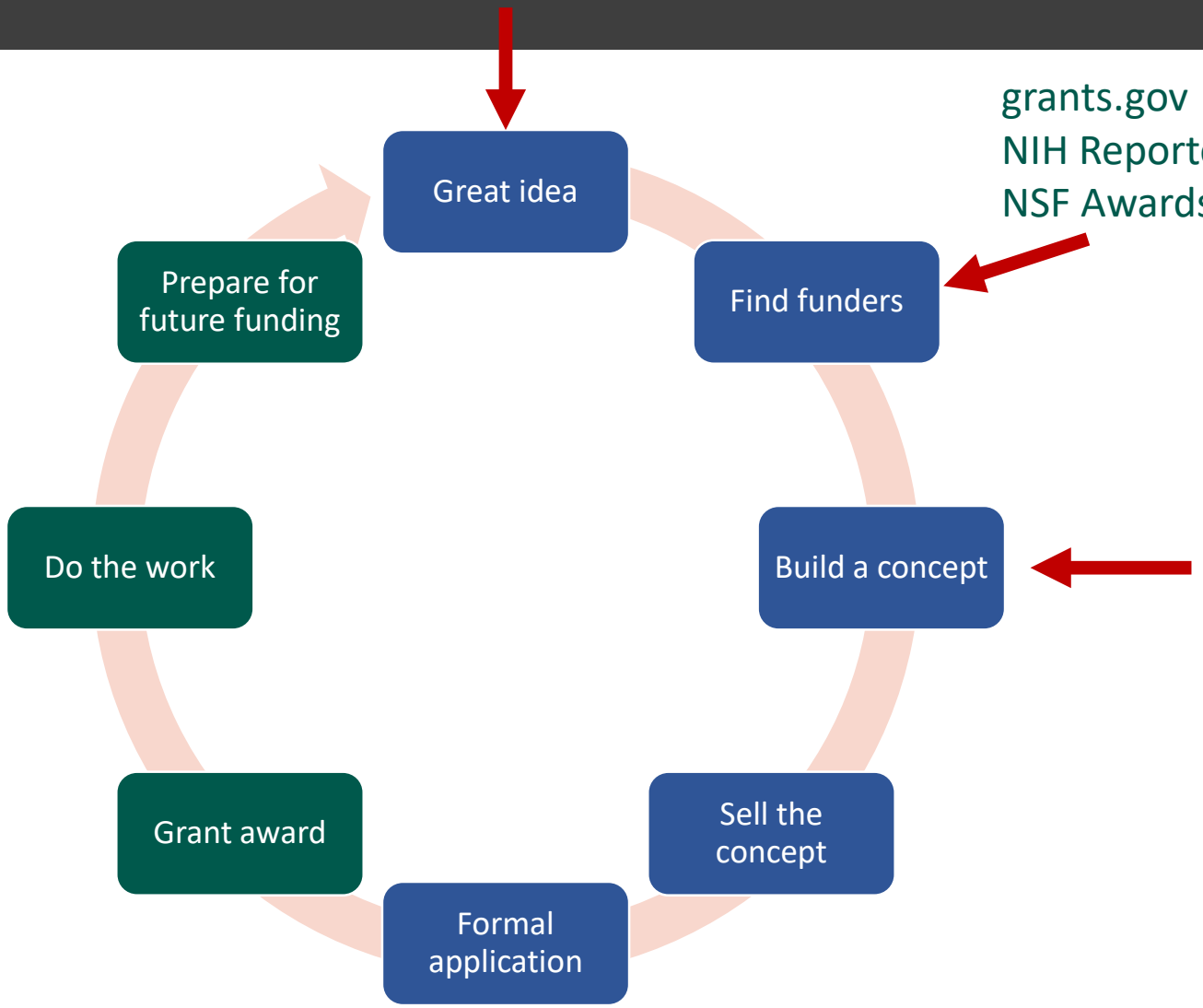
Build a concrete logic model beginning with outcomes / impact goals.

- What impact do you want your project to have?
- Given the impact you want to have, what results will you need?
- What activities will create those results?
- What resources will you need to conduct those activities?

Resources	Activities	Results	Impact

For more information: Developing a Logic Model or Theory of Change

THE GRANT PROCESS



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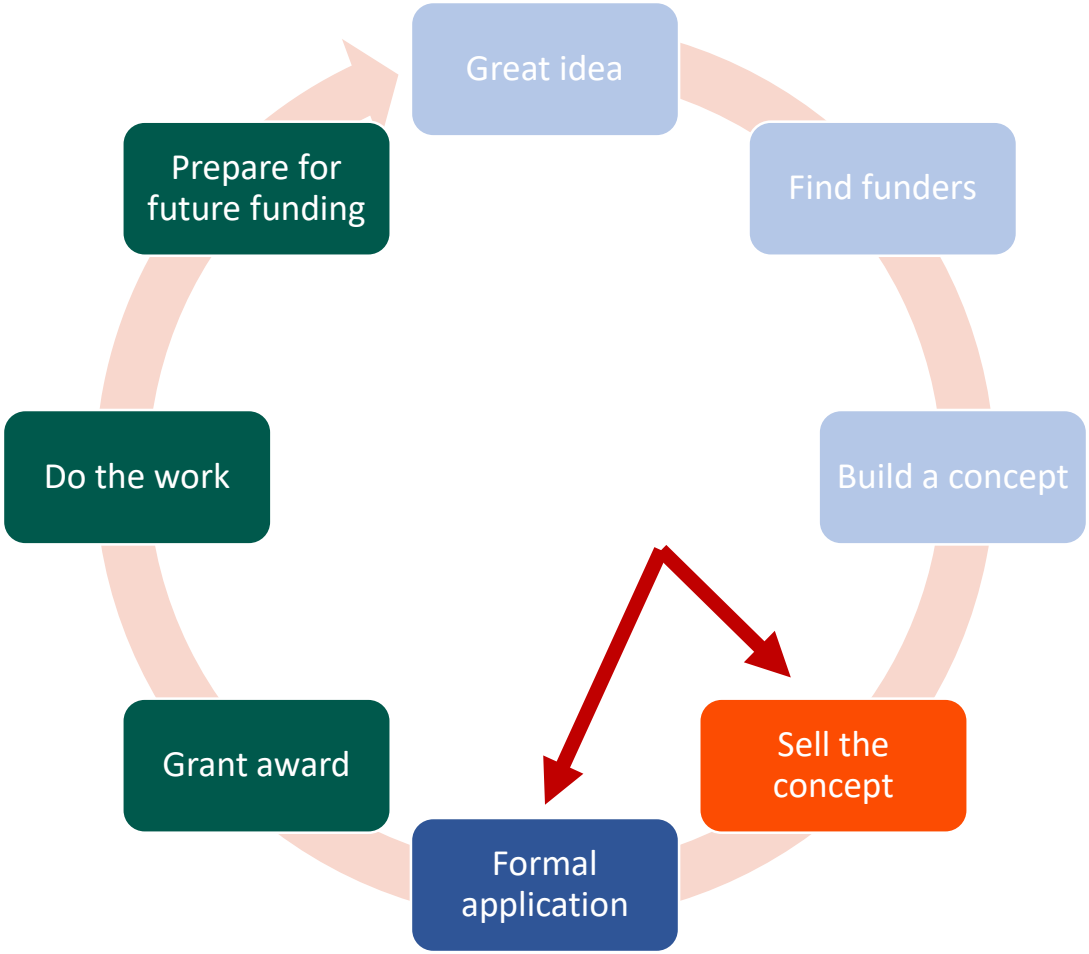

DEVELOPING A TESTABLE HYPOTHESIS

INTERESTING QUESTION! BUT IS IT TESTABLE?

A good question is not enough– the key to creating strong aims and a strong proposal is to start with a strong hypothesis

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A good question is not enough– the key to creating strong aims and a strong proposal is to start with a strong hypothesis

(Usually. Some foundations and agencies fund more exploratory research. In that case, you must still have a very clear and focused concept with clear and focused deliverables.)

BUT START WITH THE QUESTION

- Start with a question
  - Does smoking cause cancer?
- Get specific
  - Are mice exposed to cigarette smoke more likely to develop lung cancer?
- Make it testable
  - If mice are exposed to cigarette smoke, they will develop lung cancer.

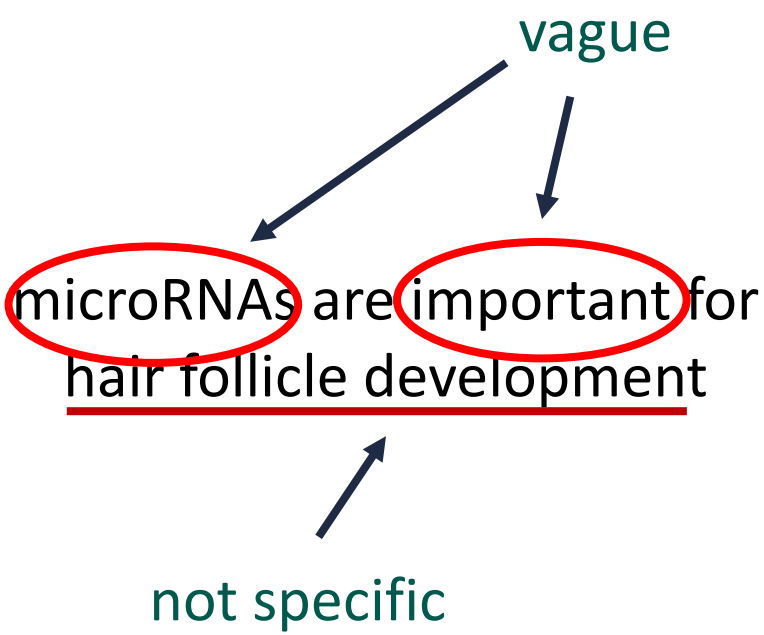
A GREAT HYPOTHESIS IS…

- Logical
  - Supported by a literature search and preliminary data
- Testable
  - With resources you have access to
  - With your expertise
- Focused
  - It addresses a specific unknown
- Simple
  - No great leap in logic

LANGUAGE MATTERS

microRNAs are important for hair follicle development

LANGUAGE MATTERS



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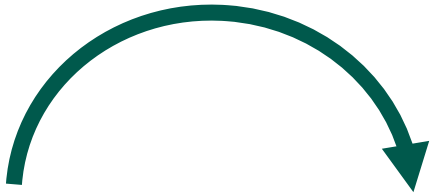


microRNAs are important for hair follicle development

miR-205 is required for hair follicle development in mice

specific & testable

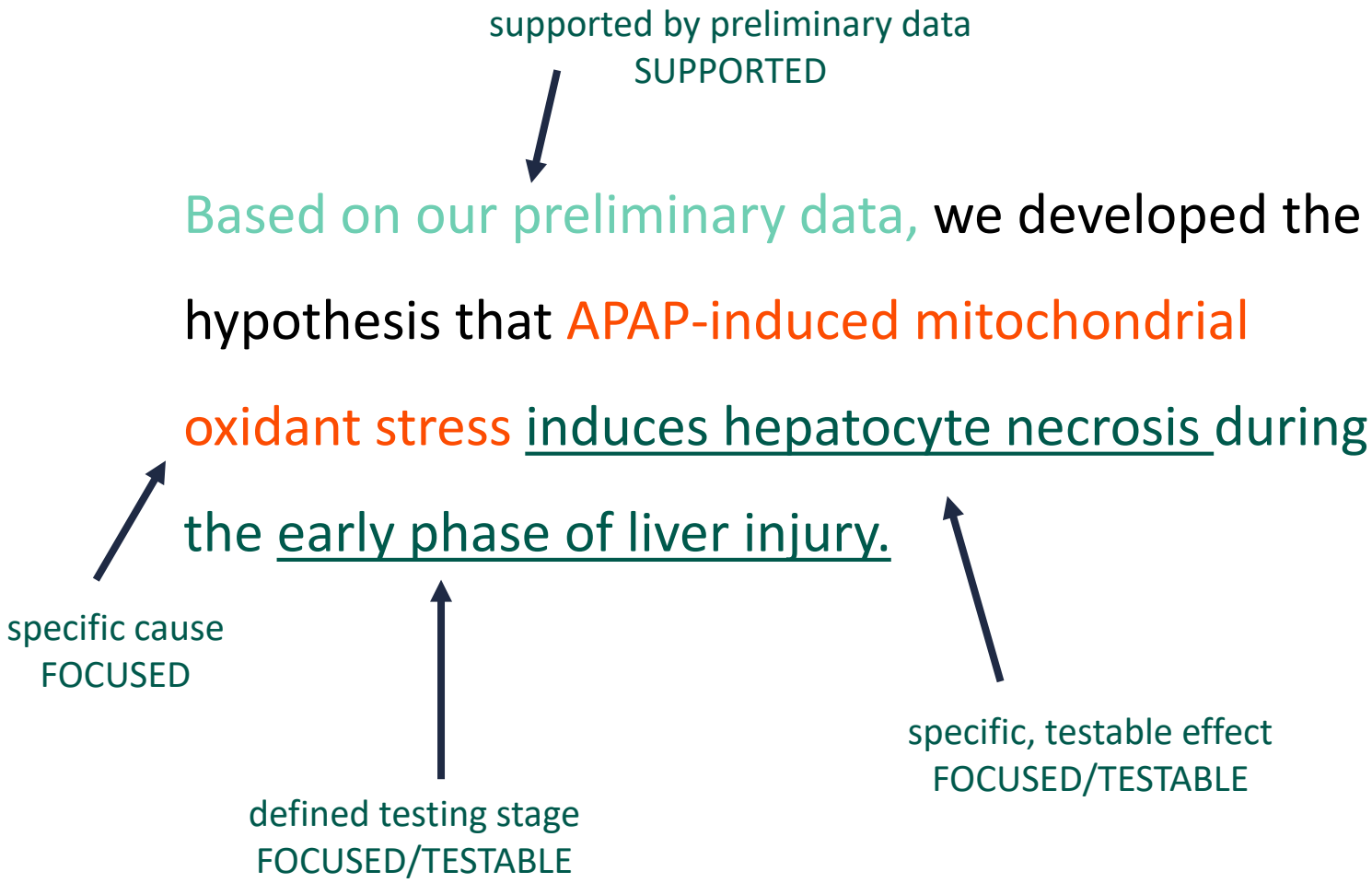
REAL EXAMPLE

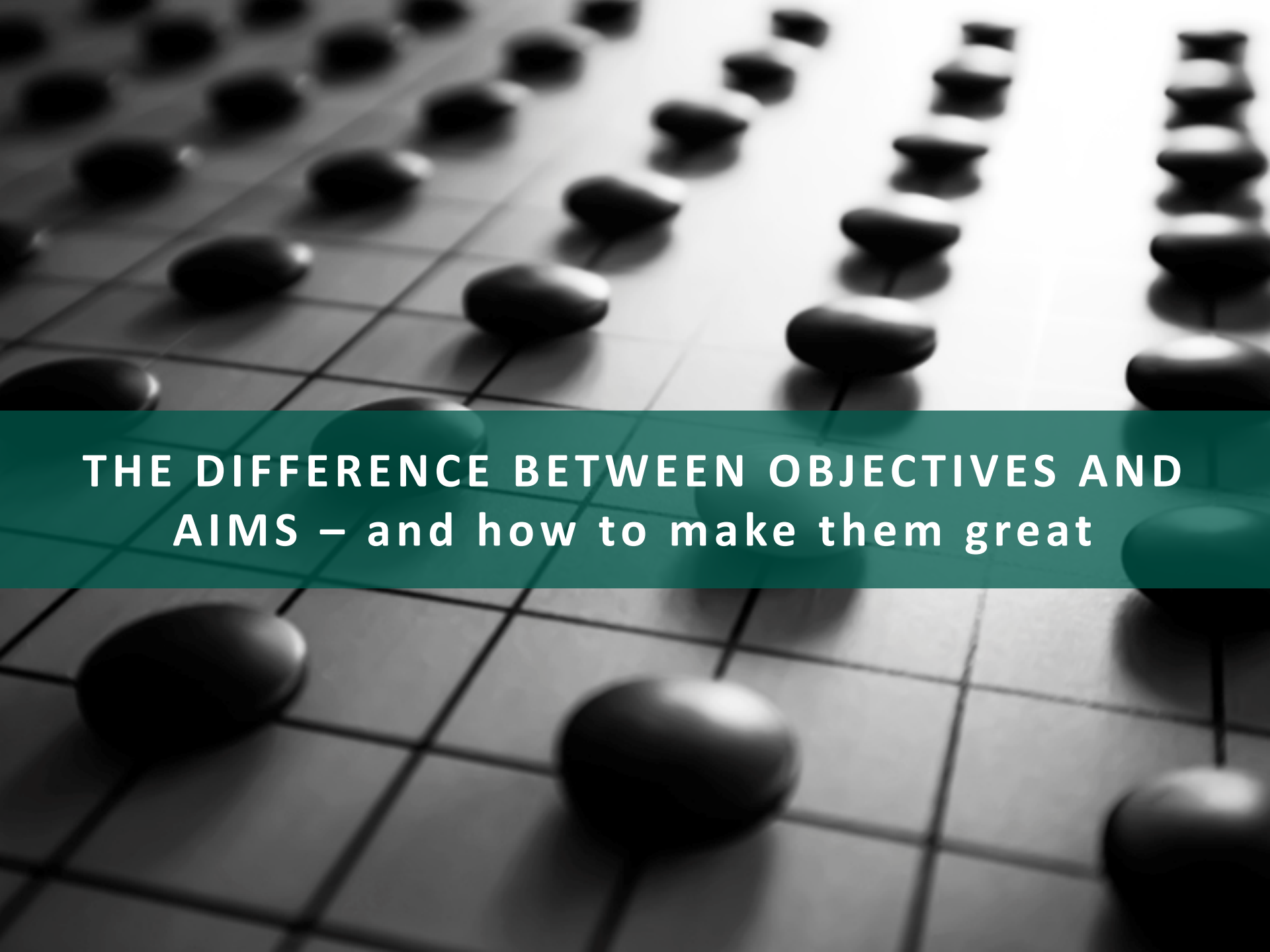
Based on our preliminary data, we developed the hypothesis that APAP-induced mitochondrial oxidant stress induces hepatocyte necrosis during the early phase of liver injury.

What makes this hypothesis:

- Supported?
- Testable?
- Focused?

EXAMPLES


supported by preliminary data
SUPPORTED
Based on our preliminary data, we developed the hypothesis that APAP-induced mitochondrial oxidant stress induces hepatocyte necrosis during the early phase of liver injury.
specific cause
FOCUSED
defined testing stage
FOCUSED/TESTABLE
specific, testable effect
FOCUSED/TESTABLE



THE DIFFERENCE BETWEEN OBJECTIVES AND AIMS – and how to make them great

WHAT'S THE DIFFERENCE?

OBJECTIVES versus AIMS	
Overarching goal that will be achieved, typically broken down into tasks	Brief, should be concisely defined
Define the structure of the research project– typically used for more exploratory proposals	The link between the research project and the question that motivates it—typically used for hypothesis-driven proposals
Often used for programmatic opportunities, the NSF, and USDA	Best known as *Specific Aims* of the NIH

Well-articulated objectives and aims enable the success of a research project

S.M.A.R.T. OBJECTIVES

Articulate specific objectives of the project.

Objectives should be S.M.A.R.T. targets – an approach common for programmatic proposal development

<u>S.M.A.R.T. objective</u>:

By project month 12, provide 10 hours of training in lab techniques to 50 undergraduate students.

<u>Not-so-S.M.A.R.T. objective</u>:

Train students in lab techniques.

S.M.A.R.T. vs. NON-S.M.A.R.T. OBJECTIVES

Objective:

Jog 4 times per week for 10 weeks.

Outcome:

Complete a marathon in 2020.

Objective:

From February 1 through April 15th, jog 4 times per week, averaging 20 miles weekly at a pace of 9-minutes-per-mile.

Outcome:

On April 16, 2019, complete the Boston Marathon in 4 hours – a 10-second-per-mile improvement compared to 2017 – or better.

AIM STRUCTURE

Make sure each aim has

- A rationale
- Information on what will be tested
- Expected outcome
- Indication of the context
  - contribution the aim makes to the overall project

WHAT'S WRONG?

- Hypothesis: A causes B
- Aim 1: Determine that A causes B
- Aim 2: Determine how A causes B

WHAT'S WRONG?

only relevant to one aim

- Hypothesis: A causes B

implies that you already know A causes B

- Aim 1: Determine that A causes B

- Aim 2: Determine how A causes B

what if A doesn't cause B?

IN THE REAL WORLD…

- If you have a strong, focused concept, it is common (and acceptable) to propose a separate hypothesis for each aim, rather than an overarching hypothesis
- As you navigate the process from concept to proposal, it can still be very helpful to start with a broad central hypothesis, and get more specific from there

EVALUATING YOUR AIMS & OBJECTIVES

- Would someone familiar with your field agree that accomplishing these objectives will lead to the achievement of your goal?
- Are they Specific, Measurable, Achievable, Relevant and Timebound (as much as possible)?
- Are the objectives structured logically according to your research question or hypothesis?

If you can answer all of these questions in the affirmative, you're ready to move forward

THE NSF PROJECT SUMMARY

A very important single page.

Three sections are required:

1. Overview
   -Activities, objectives, and methods

2. Intellectual Merit
   -Knowledge to be created, impact on the scientific field

3. Broader Impacts
   -Impact on society and NSF's goals

Source: NSF Proposals and Awards Policies & Procedures Guide, NSF 19-1, February 25, 2019.

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Objectives

A Project Summary is not an abstract but typically includes the **objectives** of a proposed project. NSF uses the Project Summary to sort and screen proposals.

Source: NSF Proposals and Awards Policies & Procedures Guide, NSF 19-1, February 25, 2019.

THE SPECIFIC AIMS SECTION

The *Specific Aims* section is arguably the **most important** part of the application.

- Different sources describe *Specific Aims* as an overview of project, the template or master plan for the rest of your Research Plan, or central element of proposal.
- Due to its nature and significance, experts frequently recommend that this be the initial section that is generated (for an NIH proposal).
- It is often noted that producing a clear, precise, concise statement of specific aims is a challenge.

Multiple revisions are required and input from colleagues and team members can be helpful.

Sources: BioScience Writers (April 9, 2015); Dresbeck (2013); Giddings (n.d.); NIH (November 25, 2015); Univ. of Washington (n.d.)

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Aims

Sources: BioScience Writers (April 9, 2015); Dresbeck (2013); Giddings (n.d.); NIH (November 25, 2015); Univ. of Washington (n.d.)

An experienced PO once said,
"Think of your proposal as the 40th in a stack."

Always assume that your reviewer is exhausted!

SPECIFIC AIMS: THE NIH AS A CASE STUDY

SPECIFIC AIMS ARE MULTI-PURPOSE

The Specific Aims page should…

…persuade reviewers that the project is important;

…that you have the right team to do the proposed work;

…that your research proposes the next logical step to advance the field;

…and that completing the project will advance the state of science regarding human health.

Sources: BioScience Writers (April 9, 2015); Dresbeck (2013); Giddings (n.d.); NIH (November 25, 2015); Univ. of Washington (n.d.)

LET'S OVERSTATE THE IMPORTANCE

The **importance** of the Specific Aims page cannot be overstated because …

- It will be used by the SRO to recruit reviewers for your application.
- Most members of the NIH Study Section will only read the Specific Aims (and Project Summary / Abstract).

Sources: BioScience Writers (April 9, 2015); Dresbeck (2013); Giddings (n.d.); NIH (November 25, 2015); Univ. of Washington (n.d.)

THE "ANATOMY" OF A SPECIFIC AIMS PAGE

Organize bullet points in *four* distinct categories that will become four paragraphs

1. Introductory paragraph – define the problem/critical need
2. Proposed idea/solution paragraph – provide objective(s) and rationale (who, what, why)
3. Specific Aims listing – brief (1 sentence) and identify "product" over "process" to meet the project's objectives.
4. Significance paragraph – conclude with the novelty of the work, expectations, and anticipated impact

Sources: Colson (2009); Dresbeck (2013); Giddings (n.d.); Jelinski (n.d.); NIH (November 25, 2015); Univ. of Washington (n.d.)

AIMS STATEMENT "DO'S"

Aims are the actions to be taken to test the hypothesis (the key steps necessary to fulfill the objective and address the critical need). They should:

- Be a natural extension of the hypothesis
- Be brief, informative, and attract the reviewer's attention.
- Convey why each part of the research is being done, but should not detail methodology.
- Ideally result in something measurable.
- Be related but not interdependent.

Sources: BioScience Writers (April 9, 2015); Dersbeck (2013); Giddings (n.d.); NIH (November 25, 2015); Univ. of Washington (n.d.)

AIMS STATEMENT "DON'Ts"

Aims should not

- Introduce new ideas
- Be sequentially dependent
- Be descriptive
- Be unrealistic (the goal is ambitious but attainable)
- Be non-committal (i.e., *determine whether*)

Sources: BioScience Writers (April 9, 2015); Dersbeck (2013); Giddings (n.d.); NIH (November 25, 2015); Univ. of Washington (n.d.)

HOW TO WRITE COMPELLING SPECIFIC AIMS

- Briefly state each of the aims you will use to test your hypothesis.
- Within 2-4 sentences each, describe the experimental approach and how each aim will help answer your larger hypothesis.
    - A typical NIH R01 grant will have between 2 and 4 Aims. Plan to describe each aim in a separate paragraph.

Additionally, these tips may help you to formulate your aims section:

- Give your aim an active title that clearly states the objective in relationship to the hypothesis.
- Include a brief summary of the experimental approach and anticipated outcomes for each aim.
- If you have room, you may wish to include a and a small description of the pay-off of each aim.
- To make it easier for the reviewers to clearly read and understand each aim, it is often helpful to use headings and/or bullets to delineate each specific aim.

PITHY AIMS: EXAMPLE #1

Some researchers prefer very short Specific Aims while others use statements like these as headers.

- *Assess the extent to which AH1 is downregulated by NEURO1 ablation*
- *Identify the extent to which insulin resistance is affected by NEURO1 ablation.*
- *Measure whether NEURO1 null mice are more susceptible to inflammation.*

Source: Dresbeck (2013)

SENTENCE-LENGTH AIMS WITHOUT HEADERS: EXAMPLE #2

Some successful NIH researchers use numbered Specific Aims without descriptive headers.

- **AIM 1.** Establish safety, feasibility and accuracy of NIR fluorescence image-guided SLN dissection in patients with Stage I and II lung cancer.
- **AIM 2.** Compare detection of NIR fluorescence image-guided SLN identification and excision with conventional staging lymphadenectomy.
- **AIM 3.** Assess the predictive value of the detection of “occult” nodal metastatic disease on subsequent disease recurrence.

Source: Colson (2009).

PARAGRAPH-LENGTH AIMS WITHOUT HEADERS: EXAMPLE #3

Numbered Specific Aims without descriptive headers are also fairly common.

- **Aim 1** will establish an innovative mouse model for HTLV-1 Tax tumorigenesis. Targeting vectors containing silenced wild-type or mutant Tax genes will be knocked in to the Rosa26 locus of C57BL/6 mice. These mice will then be crossed with homozygous Lck-CRE mice, thereby excising the stop cassette and generating mice that express wild-type or mutant Tax proteins specifically in T cells.
- **Aim 2** will examine the effect of mutations that disable specific biological functions of Tax on Tax-mediated tumorigenesis. Tax can bind to and regulate the activity of members of the SRF, CREB, NF-kB and PBM protein families, each of which has been implicated in oncogenesis. Mice established in Aim 1 will allow us to compare for the first time the tumorigenic potential of wild-type and mutant Tax proteins in an effort to identify pathways that are required for Tax tumorigenesis.

Source: BioScience Writers (April 9, 2015)

SPECIFIC AIM WITH HEADERS AND EXPLICATIVE INFORMATION: EXAMPLE #4

The goal of Specific Aims is to provide a brief summary of research intention, approach, and anticipated outcomes. An explicit ordering of information in this sequence can be helpful.

Aim 1: Develop algorithms for C. elegans viability assays to identify modulators of pathogen infection

Challenge: To identify individual worms in thousands of two-dimensional bright field images of worm populations infected by Microsporidia, and measure viability based on worm body shape (live worms are curvy whereas dead worms are straight).

Approach: We will develop algorithms that use a probabilistic shape model of C. elegans learned from examples, enabling segmentation and body shape measurements even when worms touch or cross.

Impact: These algorithms will quantify a wide range of phenotypic descriptors detectable in individual worms, including body morphology as well as subtle variations in reporter signal levels.

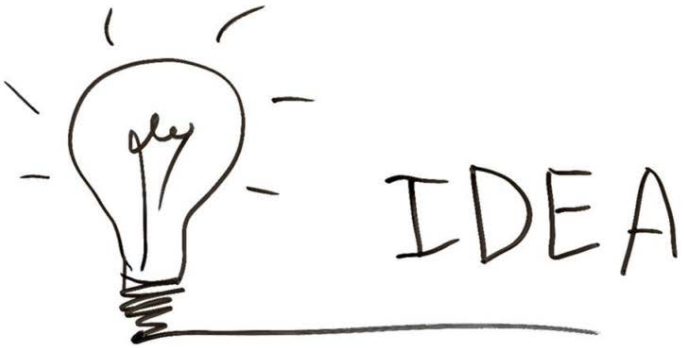
Source: BioScience Writers (April 9, 2015).

WHATEVER FORMAT YOU DECIDE UPON…

Make sure that reviewers have enough information to recognize that the project:

- **Fills** a demonstrable **gap** (e.g., in services or knowledge)
- Is **innovative** and interesting to people in the field
- Will produce something of **value** within a specified timeframe
- Will have a **strong, measurable impact**
- Is **timely**

IF PEOPLE IN YOUR FIELD GET EXCITED ABOUT YOUR IDEA, YOU ARE ON TO SOMETHING.




“LET’S DO THIS!” –FUNDER

PRESENTATION SOURCES

Aims and Objectives, why the world needs your research. Retrieved from: https://parkerderrington.com/aims-and-objectives-why-the-world-needs-your-research/

BioScience Writers. (April 9, 2015). NIH grant applications: the anatomy of a specific aims page.

Colson, Y.L. (2009). Hypothesis and specific aims. AATS Grantsmanship Workshop.

Dresbeck, R. (2013). Writing a great specific aims page. Oregon Health and Science University.

Giddings, M. (2009). NIH grant writing tips - #1. Morgan on Science blog.

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U.S. Department of Health and Human Services. (January 8, 2016). PA-16-072: behavioral and integrative treatment development program (R01).

U.S. Department of Health and Human Services Public Health Service. (December 7, 2018). SF424 (R&R) Application Packages NIH and other PHS agencies.

University of Washington. (n.d.). Grantsmanship 101: developing and writing effective grant applications – session 3: crafting effective specific aims.

Wahlby, C. (n.d.). NIH proposal. Retrieved from: http://www.niaid.nih.gov/researchfunding/grant/documents/wahlbyresplan.pdf

RESOURCES FOR PROPOSAL DEVELOPMENT

- The **National Organization for Research Development Professionals (NORDP)** maintains a Writing a Grant 101 page, which includes links to many useful guides, as well as a more general Resources page.
- The **Foundation Center** provides a Proposal Writing Short Course tutorial, focused more on private grants.
- The **NSF** Proposal and Award Policy and Procedures Guide is indispensable, particularly Part I, the Grant Proposal Guide.
- The **NIH Office of Extramural Research** (OER) offers guidance for Writing the Application and the **NIAID** offers excellent application samples.

AND, don't forget about Grantwriting Support at UCONN!

- https://ovpr.uconn.edu/services/research-development/grantwriting/#

QUESTIONS?

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