# Principles of writing grants

John P. Kastelic DVM, PhD, Dipl. ACT
Professor of Theriogenology
Head, Department of Production Animal Health
Faculty of Veterinary Medicine

# Background

- Funds to support materials, equipment and support for people
- Usually a competition; goal is to support research with substantial impact and reasonable probability of success
- Proposal must indicate potential significance, impact and feasibility
- Detailed description of previous and current work, training and skills, innovative ideas and goals, appropriate study design
- Should be easy to read, concise and attractive.
- Include headlines, subheadings, highlighted parts, figures, data
- Funding source and review panel should match proposal and investigator

# Funding sources

- Identify funding agency or institution with funding opportunities that fit the main idea or purpose of the research
- Ideally, overall objective of research should be an ideal fit
- Strongly discouraged to invent a new project or substantially change a project to match opportunities

# Small pilot grants

- Fund early-stage projects to generate preliminary data for a large project
- Collect and analyze preliminary data, proof-of-concept for hypotheses and specific aims of long-term objective
- Overall objective, level of innovation and originality are important
- Projects should be small, focused and short duration
- Internal funds, possibly national or international

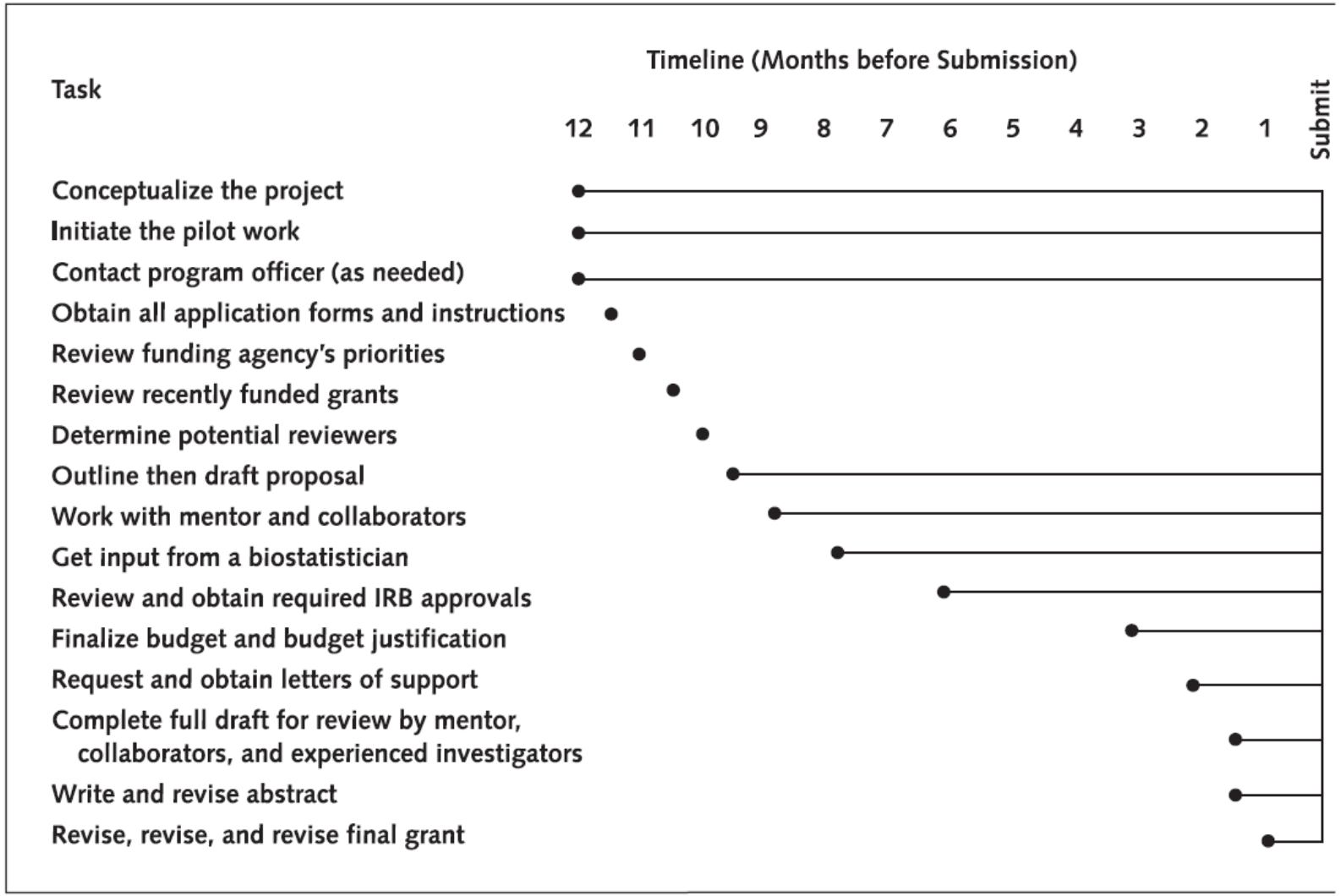
# Research grants

- Often provide moderate amounts of funding for 3–5 years
- Often require substantial preliminary data
- Significance, innovation, investigator, approach and work environment are seriously considered

# Training, education and career development grants

- Mainly for early-career researchers
- Goal is often “to develop an independent research career in …” plus a description of proposed work
- Clearly stated rationale, specific aims, and expected outcomes
- Candidate’s and mentor’s credentials are important
- Scientific and technical merit, potential of the candidate, quality of the training plan, quality of the mentorship, research environment, and institutional commitment are important

# Timetable and logistics




*Ann Intern Med.* 2005;142:274-282.

# Two (opposite) types of grants

- Hypothesis-driven and hypothesis-generating
- Hypothesis-driven grants are usually preferred for biomedical research
- Hypothesis-driven: hypothesis guides development of entire proposal
- Hypothesis-generating: uses methodology (e.g., genomics) to explore a phenomenon of interest (e.g., gene expression in a specific disease) that will inform future hypotheses to guide further research.

# Criteria for a hypothesis-driven grant

- Driven by a hypothesis
- Innovation, mechanistic orientation, appropriate preliminary data and relevant experimental design
- Adequate environment and resources to conduct the work
- Scientific stature of the applicants
- Budget is complete, appropriate and justified
- Milestones and appropriate time-table
- Regulatory requirements (animal care, biohazards, ethics, etc.)

# Innovation

- “application of better solutions that meet new requirements, unarticulated needs or existing market needs”
- New and substantive departure from status quo, new opportunities
- Can be technical or conceptual
- To communicate this, there are three critical components:
- (1) description and clarification of status quo through citations
- (2) explicit statement of innovation in the proposed research
- (3) description of the new research horizons, preferably relevant to funding agency’s mission, attainable through innovation in this project

# Approach

- Brief introduction, preliminary results, detailed research design, and expected outcomes, ± literature review and citations
- Introduction and preliminary results are used to provide justification and feasibility of each aim and task.
- Critical to keep it: (1) easy to read, (2) concise and (3) attractive
- Include:
- 1) research design details, including statistical analysis on preliminary data and power and sample size calculations
- (2) description of potential problems and alternative approaches

# Abstracts

- Two distinct types:
- (1) scientific abstract, intended for scientific community
- (2) lay person abstract, information for general population
- Capture entire proposal, stand-alone, match target audience
- Usually has long-term goals, current goals, biological/biomedical significance, **central hypothesis**, 2 to 5 (usually 3) **specific aims** and their hypotheses, connected to experiments that test the central hypothesis, experimental design and methods, and expected outcomes
- Usually read first and creates ‘everlasting first impression’
- Often written last, much can be copy and paste

# Rationale (Background)

- **NOT** a literature review!
- Literature is cited, NOT to define what is already KNOWN…
- Rather, it is cited to define what is **NOT known**
- Rationale for why you are asking the question….Why is it important?
- Requires detailed familiarity with the literature
- Take it apart…….and put it back together

# Common problems with the background

- Failed to justify the need for the study
- Provided too much extraneous background information
- Overstated the significance of the study

# Hierarchy of goals

- **Long-term overall objective**, ultimate aim of research program, including proposed project
- **Shorter-term goals** describe gaps in knowledge/techniques, critical needs
- **Specific aims** that will fill the gaps and address the critical needs
- Critical to describe relationship between overall objective and specific aims
- Three key points
- (1) Overall objective (what new knowledge or possibility is created)?
- (2) Rationale (critical need and gap in knowledge or technique)
- (3) Specific aims (objectives and milestones that address overall objective)

# Specific aims

- Series of experiments, if successful, will conclusively address a specific aspect of the overall objective
- They answer the question “What are you going to do?”
- Details of the how each specific aim will be addressed are in research strategy section

# More about aims

- Each of the aims is related to others to ensure a common theme
- Aims must be interdependent but NOT dependent on success of others
- Usually avoid experiments that are correlative in nature and those which will provide results that are observational and poorly mechanistic
- At the end of the proposal, have a brief statement on your vision of how the results of the proposed research will significantly (rather than incrementally) expand the current understanding and address a knowledge gap; why is it so important that the study be performed and thus be funded?

# Adding credibility to your proposal

- Illustrate background with clarifying cartoons, e.g., cartoons of pre-existing models and your proposed models (highlighting their novelty)
- Organize preliminary data according to specific aims
- Preliminary (and published) data justifies proposed experiments
- Base your hypothesis on preliminary data to show the hypothesis-driven nature of your research.
- Indicate investigative team has skills and experience in this research
- Experimental design is perhaps the most important section
- State the central hypothesis and how this will be tested by each aim

# Central hypothesis

- Narrowest testable outcome of the proposed project in funding period
- Clearly defined in the objectives/specific aims (etc.) as the single overarching question that needs to be answered
- A good hypothesis can be broken into parts, each tested by specific aims.
- E.g., ‘the current study is guided by the central hypothesis that drug X interferes with the signaling pathway Y by a mechanism involving Z ‘
- The central hypothesis is followed by specific aims that break down the central hypothesis into, for example, 3 aims, the hypotheses of which are derived from the central hypothesis

# Hypotheses

- Must be based on evidence that is supported by preliminary data and is compatible with established facts
- Novel and stated clearly in the present tense and active voice
- Must lead to observable consequences that are readily tested.
- Evidence, facts, tests and alternatives must be described
- **Appropriate form**: “the central hypothesis is that A causes B”
- **WRONG form**: “the central hypothesis is if A causes B” or “the central hypothesis is to prove that A causes B”

# Hypotheses and aims

- Must be in clear, easy to understand and quantifiable terms.
- **The entire application depends on getting this right!**
- Often stated: …we aim to study…, we aim to measure…, we are the first to measure this and we will measure lots of people, with state-of-the-art technology that we are the first to have…
- Aims are often aimless and hypotheses are often never stated or too vague
- **If you don’t know what you want, no one else will!**

# Experimental design and methods

- Content and organization of the Methods section must follow hypotheses
- Each hypothesis is addressed by a given method, with sample size based on power calculations, ideally from pilot data
- Every measurement should be justified and relevant to testing the hypothesis

- Two critical tasks:
- (1) Convey your message to the reviewer within page limits
- (2) convince the reviewer that you are fully capable of accomplishing the specified goals and objectives of the grant within the proposed time frame

# Preliminary studies and pilot work

- Commonly lacking, inadequately described, or not well linked to proposal
- Summarize investigator's previous work related to the project.
- Evidence that: 1) investigator has the expertise and experience; 2) work is feasible, and 3) suitable groundwork has been done.
- Present the specific objectives, methods, results (with brief description and data) and significance

# Significance

- Main positive impact of the research project on the subject related to the mission of the funding agency.
- Usually three main components:
- (1) identification of **gaps and critical needs** through background and literature review (with appropriate citations)
- (2) expected contributions to address critical needs and significance of the contributions through focused, highlighted statements
- (3) positive impacts of the project

# Why should this grant be supported?

- Clearly highlighted in the three key areas of the grant:
- 1) significance section
- 2) the abstract and project summary section
- 3) section that describes the innovation and approach.

**Useful phrases**

- Thus, these studies demonstrate the importance of this area [elaborate here]"
- "These studies provide the important background for this study in. . ."
- "The proposed project will build on this previous work [or address limitations in the previous work by]. . .

# Credibility and feasibility

- 1) well-designed studies, 2) preliminary results, 3) appropriate statistical analyses, and 4) potential problems with alternative solutions
- Seek advice on questions reviewers may ask and answer them explicitly
- Potential problems described should have low probability of occurrence; otherwise, they should be considered more seriously in the study design

# Budget and personnel

- Based on needs and funding agency's policies and instructions
- Should have clear justification for each cost
- Personnel should have all necessary experience and skills, but avoid redundancy in skills and overlap in tasks
- Clear description of each person's expertise and role in project
- Detailed letters of commitment from collaborators, describing their expertise, role in the project and their commitment

# Environment and resources

- Location or environment, available resources (independent and shared facilities), and proximity and access
- Facilities section may describe lab and office space, animal and clinical equipment, and computer resources
- Institutional commitment regarding space, equipment, research time and administrative support, funding, career development opportunities
- Intellectual resources and collaborations
- Reviews for ethics, animal care, etc.

# Advice and input from a biostatistician

- Input on the methods and analyses from an experienced biostatistician will enhance the success of your proposal
- Seek advice early on for input about study design, data analysis plans, and sample size calculations

# References cited

- Easy to read and uses space wisely (avoid excessive punctuation)
- Critical and up to date references
- Minimize errors

# Other considerations

- For many grants, your teaching experience, philosophical approach to teaching and the proposed training environment, are an important part of the grant
- Equity, diversity and inclusion are also becoming very important

# General issues and how to avoid them

- Poor layout and formatting, typographical errors, small fonts sizes, excessive topic-specific jargon or abbreviations, and information in wrong
- Give time and attention to proofreading and making grant easy to read, with highlighting and spaces between paragraphs and between sections
- Charts, flow diagrams, pictures, and color
- Enough “white space” for easy reading while still filling each section
- Address study limitations thoroughly and realistically

# The review process

- Often provided by funding agency or institution
- Read BEFORE starting to write; target proposal to match expectations and to highlight grant agency priorities and requests.
- AVOID dense writing, complex words or acronyms, slang, complex illustrations
- USE descriptive headlines, simple sentences and purposeful illustrations

# Reviewers, committee and chairpersons

- Busy, many grants to review in a limited time
- If possible, determine who is likely to review your proposal
- Unlikely to work in your specialized field, avoid slang or topic-specific abbreviations or terminology
- Entire grant must be easy to understand in a single reading
- Relevance, focus, conciseness, conceptual clarity, and transparent language
- Proposal should be completely self-contained
- You need to convince them of your ideas and your abilities
- DO NOT annoy or frustrate them!

# Common review criteria and their meaning (i.e., questions that reviewers should be able to answer)

- Significance: Does the project address a critical problem?
- Innovation: Will there be development of new knowledge or methods?
- Investigators: Are investigators and collaborators capable?
- Approach: Will the proposed research approach accomplish the objectives?
- Environment: Are project site and environment appropriate for success?

# Critical elements

- Clear statements about the significance, rationale and innovation
- Detailed description of a research plan that builds upon an innovative idea that addresses a critical need and fills a gap in knowledge or technology
- Convey your enthusiasm and communicate with your reviewers through clear writing and effective illustrations
- Avoid flawed project design, unfocused hypotheses or specific aims, lack of significance or innovation, or overly ambitious project design
- Provide information that facilitates reviewers addressing review criteria
- Describe experience and expertise of investigators, their unique environment and ability to deliver what is proposed

# Follow all the rules

- Read and follow all of the guidelines EXACTLY
- Determine requirements for animal care, ethics, etc.
- Follow instructions regarding fonts, margins, format and content
- Grammatical and typographical errors are very negative
- Investigator’s name, grant number and page number on every page
- Ensure you have all signatures and approvals
- Do not expect flexibility about submission dates

# Useful advice

- Create a diversified research portfolio, using funds from various sources to fund specific costs or kinds of research
- Work with office of ‘research services and grants’ at your institution
- Consult databases regarding potential grant opportunities
- Read successful proposals, seek advice, have people to assist you
- mentors and colleagues to assist you
- Have ample time to work on this
- Most important criteria: innovation, hypothesis-driven, mechanistic, state-of-the-art methodology, feasibility, and biomedical importance

# Allow time for prereview and revision

- Internal deadline 4 to 6 weeks before the actual deadline
- Ensure time to preview by mentors and colleagues (2 wk)
- A high-quality product is critical
- Allow ample time to refine budgets and subcontracts, and to obtain letters of support

# Getting started

- Writing a grant proposal is similar to writing a manuscript
- Getting started is no fun……..
- In fact, it is agony!
- Just sit down and start, write something, anything, just…….write!!

# Contact Information

**jpkastel@ucalgary.ca**

**therio@shaw.ca**