

## BIOLOGY 685 – Advanced Topics in Biology: Advanced Experimental Design Syllabus Fall 2008

**Texts:** Scientific Method for Ecological Research by E. David Ford,  
Experimental Design & Data Analysis for Biologists by G.P. Quinn & M.J. Keogh

**Lectures:** Tuesday & Thursday 4.00-5:15 pm in Engineering 342

**Instructors:**

**Dr. Ian van Tets:** Office hours Tues/Thurs 10– 12 Office: EBL 124 Ph: 786-4705  
[afvt@uaa.alaska.edu](mailto:afvt@uaa.alaska.edu)

**Prof. Donald Spalinger:** Office hours Mon/Weds 3:30-5 PM Office: Eng 310 Ph: 786-4703  
[afdes@uaa.alaska.edu](mailto:afdes@uaa.alaska.edu)

Day	Date	Topic	Ford	Quinn & Keogh	Instructor
Tues	Aug 26	Component processes of ecological research	1		DS
Thurs	Aug 38	Processes of research planning	2		DS
Tues	Sept 2	<b>LABOR DAY – NO CLASS</b>			
Thurs	Sept 4	Processes of research planning	2		DS
	Sept 9	<b>Add/Drop &amp; Payment deadline</b>			
Tues	Sept 9	Conceptual & propositional analysis	3		DS
Thurs	Sept 11	Conceptual & propositional analysis	3		DS
Tues	Sept 16	Development of a research plan	4		IvT
Thurs	Sept 18	Development of a research plan	4		IvT
Tues	Sept 23	How theories develop and how to use them	5		DS
<b>Thurs</b>	<b>Sept 25</b>	<b>DISCUSSION OF PROPOSAL DRAFTS</b>			IvT & DS
Tues	Sept 30	The art of measurement & experiment	6		IvT
Thurs	Oct 2	The art of measurement & experiment	6		IvT
Tues	Oct 7	Methods of reasoning in research	7		DS
Thurs	Oct 9	Methods of reasoning in research	7		DS
Tues	Oct 14	Assessment of postulates	8	1.1 to 1.3	IvT
Thurs	Oct 16	Strategies of scientific research	11		DS
Tues	Oct 21	Strategies of scientific research	11		DS
<b>Thurs</b>	<b>Oct 23</b>	<b>DISCUSSION OF PROPOSAL DRAFTS</b>			IvT & DS
Tues	Oct 28	Probability, populations, means & variance	8	1.4 to 2.3	IvT
Thurs	Oct 30	Distributions, type I & type II error	8	3	IvT
Tues	Nov 4	Comparing means – t-tests & ANOVAs		3, 5 & 8	IvT
Thurs	Nov 6	Transformations: why, when & how?		4	IvT
Tues	Nov 11	Sample size & power analysis		7	IvT
Thurs	Nov 13	Regression & Correlation		5	IvT
	<b>Nov 17</b>	<b>Withdrawal deadline</b>			
Tues	Nov 18	Comparing frequencies – the $\chi^2$ test		14	IvT
Thurs	Nov 20	Sources of Experimental Error & The advantages and disadvantages of randomization		Hurlbert 1984	DS
<b>Tues</b>	<b>Nov 25</b>	<b>DISCUSSION OF PROPOSAL DRAFTS</b>			IvT & DS
<b>Thurs</b>	<b>Nov 27</b>	<b>THANKSGIVING – No Class</b>			
Tues	Dec 2	Pseudoreplication		Hurlbert 1984	DS
Thurs	Dec 4	Presentations			IvT & DS
Tues	Dec 9	<b>STATISTICS EXAM</b> & remaining presentations		(4 pm to 6.45 pm)	IvT & DS

## **Welcome to Advanced Experimental Design!**

**This course is intended to introduce graduate students to the key concepts of experimental design and to the application of biostatistics in their field of research.** The students are expected to apply the course material to develop their own graduate research proposal. You are encouraged to work with the course instructors, your fellow students, your advisors and your graduate committee members to make this course as relevant to the development of your own research as possible.

The class consists of two integrated sections. The **first focuses on experimental design**, the underlying theory associated with it, how this theory is put into practice and the specific use of this theory in the development of the students' individual projects. The **second focuses on biostatistical analysis**. The focus of this section is on the **application of biostatistics in biological research** rather than on the mathematical theory that underpins the various test. The aim of the statistical section is to ensure students are able to critically assess the appropriateness and validity of commonly used tests, to determine for themselves the correct test to use in their experiments and to avoid common design and statistical errors when they do so.

Feedback is encouraged throughout the course. Students are strongly encouraged to take advantage of the instructors' office hours.

## **Readings & class format:**

Students are expected to read the relevant reference and any other assigned readings **prior** to coming to class. The majority of the classes will take the form of a discussion group or tutorial based on the assigned material and guided by either Dr. van Tets or Dr. Spalinger. Attendance is mandatory and participation will be noted and assessed.

## **Assessment:**

Each student will be required to prepare a **written research proposal** and to make a short **oral presentation** to the class outlining this proposal. The written research proposal will be worth **55%** of the final assessment (5% for each of three draft proposals and 40% for the final proposal) and the oral presentation will contribute a further **10%**.

*Please see the assignment instructions at the end of the syllabus for detailed information regarding the draft and final proposals and the oral presentation!*

There will also be a **written exam** covering the statistical section of the course (Nov. 1 to Dec. 6) which will contribute **25%** to the final assessment. The remaining **10%** of the grade will be based on the individual student's **participation** in the course as determined by the two lecturers in consultation with each other.

Final course grades will be determined as follows:

100-90% = A, 89-80% = B, 79-70% = C, 69-60% = D, 59%-0% = F.

**If you experience a disability and would like information about support services, please contact Disability Support Services. Location: BEB 105 Telephone: 786-4530**

**Note:** Every reasonable effort will be made to cover the course material in the sequence presented in the schedule. However, professorial discretion and/or circumstances may lead to revision of the course content. Class attendance is expected and recorded. Students may be force-dropped for non-attendance, as stated in the catalog.

## Assignment Instructions

### Assignment 1 (proposal draft 1)

#### What is required:

1. Definition of Goals and Objectives of your research
2. List of Definitions: Concepts within the paradigm of your research subject area
3. List of Axioms of your Research Subject Area
4. Identify points of confusion, incoherency, or lack of understanding
5. Reference List (briefly annotated)

#### When is this required:

No later than **Tuesday, September 23**, 4:00 pm.

#### How should it be submitted:

Electronically, via the Blackboard site's digital drop box

If you are unable to download your assignment into the drop box, please submit your assignment via one of the following means:

- Email to Ian van Tets (afivt)
- Email to Don Spalinger (afdes)
- On a disc or other electronic medium to Ian or Don

#### Should I give it to any one else?

You do not have to but we recommend also giving a copy – electronic, paper or otherwise to the student who will be reviewing your draft. It would also be advisable to have your graduate thesis advisor review the document.

#### How should I approach this:

1. Work with your research advisor to develop the scope and subject of your research (e.g., define the broad goals and/or objectives of your research project). At this point, do not attempt to define hypotheses about your research efforts
2. Read the primary literature on the subject - start broad, narrow the focus as you gain knowledge and begin to narrow the scope of your research.
3. Explicitly define the concepts and terms of your subject matter.
4. Formulate the axioms associated with your research subject area
5. Is there any incongruency or incoherencies in the axioms of your research subject area? Spell them out.
6. Develop a literature database for your research subject area

#### Who will review whom?

**By the 23rd of September**, students will be allocated student assignments to read. **On Thursday the 25<sup>th</sup> of September**, students will be divided into groups of three and members of those groups will take it in turn to lead the discussion of the draft that they have reviewed.

## Assignment 2 (proposal draft 2)

### What is required:

#### A draft proposal written as flowing text that includes the following:

4. A **background** (introductory) section that includes:

\* a **general section** that makes the context of your work clear and that includes, clearly describes and justifies (e.g. by citation) your major **axioms**.

\* a more **specific section** that leads naturally to the aim or focus of your specific research project and that includes, in a clear and logical manner, your major **postulates**.

2. Your overarching **aim** or hypothesis or research question. You should also list, any **subordinate hypotheses** that you intend to address to achieve your overarching aim. Please don't include every possible hypothesis here – only those that are likely to require a substantial investment of research effort in their own right.

3. The **methods** you intend to use to achieve your aim and, if appropriate, to test each of your hypotheses and subordinate hypotheses. For each major technique, please also state why you chose this particular method and not at least one alternative method.

Please do not go into the fine detail of your techniques (e.g. number of test tubes, model of boat, caliber of shotgun, preferred vein for blood draws etc.). You may include a section on your analytical/statistical methods if you wish but there is no need to in this draft.

4. The **expected outcome(s)** of your research and their implications. A flow chart is likely to be helpful here.

5. A **conclusion** that **briefly** discusses your expected outcomes in the context of your background and leaves the reader with a clear picture of the relevance of your research.

#### 6. A reference List

7. A **flow chart as an appendix**. This chart should clarify: the questions you intend to address in your project, the possible answers you might get to each question, the scientific implications of each answer, and the questions that flow from each implication.

### When is this required:

No later than **Tuesday, October 21, 4:00 pm**.

### How should it be submitted:

Electronically, via the Blackboard site's digital drop box

If you are unable to download your assignment into the drop box, please submit your assignment via one of the following means:

Email to Ian van Tets (afivt)

Email to Don Spalinger (afdes)

On a disc or other electronic medium to Ian or Don

### Should I give it to any one else?

You do not have to but we recommend also giving a copy – electronic, paper or otherwise to the student who will be reviewing your draft. Again, it would be advisable to have your thesis advisor review all of your work.

### Who will review whom?

**By the 21<sup>st</sup> of October**, students will be allocated student assignments to read. **On Thursday the 23<sup>th</sup> of October**, students will be divided into groups of three and members of those groups will take it in turn to lead the discussion of the draft that they have reviewed.

## Assignment 3 (proposal draft 3 – the final draft)

### What is required:

#### A draft proposal written as flowing text that includes the following:

1. A **title**. This should be clear, relevant and descriptive. Good titles are usually 8 – 12 words long. The maximum for this project is 20 words.
2. An **abstract** describing your project in 250 words or less. This should include sentences on the background, the aim, the methods, the expected outcomes and the conclusion.
3. An **introduction** that includes the following:
  - \* a **general section** that makes the context of your work clear and that includes, clearly describes and justifies (e.g. by citation) your major **axioms**.
  - \* a more **specific section** that leads naturally to the aim or focus of your specific research project and that includes, in a clear and logical manner, your major **postulates**.
4. Your overarching **aim** or hypothesis or research question (or whatever else you want to call it). You should also list, any **subordinate hypotheses** that you intend to address to achieve your overarching aim. Please don't include every possible hypothesis here – only those that are likely to require a substantial investment of research effort in their own right.
 

This section could be a separate section or it could be the last section of the introduction. The choice is yours.
5. A **methods** section that includes:
  - \* **study site(s)** (if appropriate)
  - \* The **physical methods** you intend to use to achieve your aim and, if appropriate, to test each of your hypotheses and subordinate hypotheses. Please do not go into the fine detail of your techniques (e.g. number of test tubes, model of boat, caliber of shotgun, preferred vein for blood draws etc.). Please be sure to mention (either here or elsewhere) any **permits** that you hold or require for this work, including IACUC &/or IRB approvals if appropriate (e.g. “this project will be reviewed by the UAA IACUC committee before proceeding” or “this project has been approved by the UAA IRB, protocol XYZ 05-027.”).
  - \* The **analytical/statistical methods** you intend to use. Unless you intend to use a novel statistical approach or to develop a complex mathematical model as part of your proposal, this section can be relatively brief. It should, however, be sufficiently detailed to make the way in which you intend to assess your results clear to any reader.
6. An **expected outcomes** section. That discusses the expected outcomes of your research and their implications. A flow chart may be helpful here.
7. A **conclusion** that discusses your expected outcomes in the context of your background and leaves the reader with a clear picture of the relevance of your research.
8. A **Reference List**
  - \* Please read the document that was posted earlier on references and citations for details of reference and citation style. Please be sure to use this style for all citations and also for any appendices, figures and tables you choose to include in your proposal.
9. A **flow chart as an appendix**. This chart should clarify: the questions you intend to address in your project, the possible answers you might get to each question, the scientific implications of each answer, and the questions that flow from each implication.
10. **Anything else that you feel you are likely to include in your submitted proposal.**

#### When is this required:

No later than **Friday, November 21**, 4:00 pm.

#### How should it be submitted:

Electronically, via the Blackboard site's digital drop box

If you are unable to download your assignment into the drop box, please submit your assignment via one of the following means:

Email to Ian van Tets (afivt)

Email to Don Spalinger (afdes)

On a disc or other electronic medium to Ian or Don

#### Should I give it to any one else?

You do not have to but we recommend also giving a copy – electronic, paper or otherwise to the student who will be reviewing your draft.

#### Who will review whom?

By **Friday the 21<sup>st</sup> of November**, students will be allocated student assignments to read. On **Tuesday the 25<sup>th</sup> of November**, students will be divided into groups of three and members of those groups will take it in turn to lead the discussion of the draft that they have reviewed.

## Final Written Assignment – THE research proposal

### **Format: PLEASE READ CAREFULLY!**

Your proposal must be written in either times-new roman or courier font. It must use 1.5 line spacing. It must have margins of at least 2.5 cm (1”) on all sides of the paper. With the exception of the cover page, all pages must be numbered starting with 1 for the first page of the project description. Sections may not be longer than the page limits given below (and if they are, proposals may be returned for resubmission and marks deducted for late submission). Citations must follow the style given in the class handout. Tables and figures must have numbered descriptive titles and be cited in the text. References must follow the style given in the class handout (unless you have prior approval to use the style of a specific journal).

Marks will be deducted from proposals that do not follow these formatting guidelines precisely.

### **Cover Page: (one page)**

This should include:

#### **Name & Student number**

#### **Project title**

– This should be clear, relevant and descriptive and no more than 20 words. Good titles are usually 8 – 12 words long.

#### **Abstract**

- This should describing your project in no more than 250 words. This should include sentences on the background, the aim, the methods, the expected outcomes and the conclusion.

### **Project description: (maximum: twelve pages, not including figures)**

#### **This should include**

5. An **introduction** that includes the following:

\* a **general section** that makes the context of your work clear and that includes, clearly describes and justifies (e.g. by citation) your major **axioms**.

\* a more **specific section** that leads naturally to the aim or focus of your specific research project and that includes, in a clear and logical manner, your major **postulates**.

2. Your overarching **aim** or hypothesis or research question (or whatever else you want to call it). You should also list, any **subordinate hypotheses** that you intend to address to achieve your overarching aim. Please don't include every possible hypothesis here – only those that are likely to require a substantial investment of research effort in their own right.

This section could be a separate section or it could be the last section of the introduction. The choice is yours.

3. A **methods** section that includes:

\* **study site(s)** (if appropriate)

\* The **physical methods** you intend to use to achieve your aim and, if appropriate, to test each of your hypotheses and subordinate hypotheses. Please do not go into the fine detail of your techniques (e.g. number of test tubes, model of boat, caliber of shotgun, preferred vein for blood draws etc.). Please be sure to mention (either here or elsewhere) any **permits** that you hold or require for this work, including IACUC &/or IRB approvals if appropriate (e.g. “this project will be reviewed by the UAA IACUC committee before proceeding” or “this project has been approved by the UAA IRB, protocol XYZ 05-027.”).

\* The **analytical/statistical methods** you intend to use. Unless you intend to use a novel statistical approach or to develop a complex mathematical model as part of your proposal, this section can be relatively brief. It should, however, be sufficiently detailed to make the way in which you intend to assess your results clear to any reader.

4. An **expected outcomes** section. That discusses the expected outcomes of your research and their implications. A flow chart may be helpful here.

5. A **conclusion** that discusses your expected outcomes in the context of your background and leaves the reader with a clear picture of the relevance of your research.

**Reference List (no page limit):**

\* Please read the document that was posted earlier on references and citations for details of reference and citation style. Please be sure to use this style for all citations and also for any appendices, figures and tables you choose to include in your proposal.

**Appendices (optional, no page limit):**

\* If there are lengthy additional tables or protocols that you wish to refer to in your text you may attach them as appendices. If you do so, they must be cited in the text, e.g. (Appendix 1) and have numbered, descriptive titles.

**When is this required:** No later than **Tuesday, December 9**, 4:00 pm.

**How should it be submitted:**

Electronically, by one or more of:

Blackboard (digital drop box),	Email to Ian van Tets (afivt)
Email to Don Spalinger (afdes)	On a disc or other electronic medium to Ian or Don

## Final Oral Assignment – THE research presentation

### Summary:

You are required to make a short oral presentation to the class on your proposed research. This should be a finished and polished product. It is THE oral presentation of your proposed research (just as “assignment four” will be THE written presentation of your proposed research). It is not a draft or some other form of preliminary assessment.

### Timings:

You will be allocated 15 minutes for your presentation. You should speak for 9 to 12 minutes. The remaining time will be used for questions. You will be given a signal at the 10 minute mark. You will be asked to wrap up the talk if you are still talking at the 12 minute mark of your talk. You will be asked to stop if you are still talking at the 13 minute mark. You will be asked at least one question. You may be asked more questions if time permits. If you are in the middle of answering a question at the 15 minute mark, you will be given 30 seconds to wrap up your answer.

Presentations will be divided between the 5<sup>th</sup> and 9<sup>th</sup> of December. Speaking slots will be allocated on a first come – first served basis. Please email or otherwise let Ian van Tets know your preferred day.

### Equipment:

A power-point projector and laptop will be provided. If you wish to use them, you should provide an electronic version of your presentation to Ian van Tets (by digital drop box, by disk or via ian6776@yahoo.com) at least 24 hours prior to your presentation. If you need any other equipment for your presentation, please ensure that either Don Spalinger or Ian van Tets is made aware of this need at least 72 hours prior to your presentation.

**Grading:** You will be graded on BOTH **presentation** and **content** (5 marks for each making a total of 10).

### What you should include in your talk:

1. A **title**. This should be clear, relevant and descriptive. Good titles are usually 8 – 12 words long. The maximum for this project is 20 words.
2. An **introduction** that includes the following:
  - \* a **general section** that makes the context of your work clear and that includes, clearly describes your major **axioms**.
  - \* a more **specific section** that leads naturally to the aim your specific research project and that includes, in a clear and logical manner, your major **postulates**.
3. Your **aim** or hypothesis or research question (or whatever else you want to call it). You should also list, the major **subordinate hypotheses** (if any) that you intend to address to achieve your overarching aim. Please don't include every possible hypothesis here – only those that are likely to require a substantial investment of research effort in their own right.
4. A description of your proposed **methods**, including:
  - \* **study site(s)** (if appropriate)
  - \* The **physical methods** you intend to use to achieve your aim and, if appropriate, to test each of your hypotheses and subordinate hypotheses. Please do not go into the fine detail of your techniques (e.g. number of test tubes, model of boat, caliber of shotgun, preferred vein for blood draws etc.).
  - \* The **analytical/statistical methods** you intend to use. Unless you intend to use a novel statistical approach or to develop a complex mathematical model as part of your proposal, this should be relatively brief. It should, however, be sufficiently detailed to make the way in which you intend to assess your results clear to any reader.
5. A brief discussion of the **expected outcomes** of your research and their implications.
6. A **conclusion** that places your expected outcomes in the context of your background to leave the reader with a clear picture of the relevance of your research.
8. **Anything else that you feel you are likely to include in your submitted proposal.**
9. **An acknowledgements section:** Acknowledging those who are already providing support, advice or assistance (including your advisor, co-investigators, your department at UAA, your collaborators, your agency, etc.). Please be sure to mention the **permits** that you hold or require for this work, including IACUC &/or IRB approvals if appropriate (e.g. “this project will be reviewed by the UAA IACUC committee before proceeding” or “this project has been approved by the UAA IRB, protocol XYZ 05-027.”). **We strongly advise keeping this section to less than 30 seconds if possible.**