Designing Advanced Seminar Research Courses in Science

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Capstone Courses

“Capstone courses are culminating experiences in which students synthesize subject matter knowledge they have acquired, integrate cross disciplinary knowledge, and connect theory and application in preparation for entry into a career”.

Fairchild and Taylor, 2000
Structuring Capstone Courses

➢ **Context:**
  • Program Outcomes
  • Course Outcomes
  • Activities & Assessments
  • Enrolment (student population)

➢ **Capstone Model:**
  • Integrative Academic Perspective
  • Preparatory Perspective

Beyerlein et al., 2006; Kerka, 2001; Dutson et al., 1997; Wagenaar, 1993
Historical Background (BIO 4900)

- Programs: Honours BSc in Biology
- Student Diversity
- Course Syllabus
- In Class Participation

![Bar Chart]

**Faites vous une thèse de spécialisation? / Are you doing an Honours thesis?**

- Oui/Yes
- Non/No
Undergraduate Program Outcomes

• “Scientific method and literacy”:
  ....summarize and critique the pertinence of the information found in the primary literature and cite it properly; enumerate the usefulness and limitations of each step of the scientific method and follow the scientific method to state hypotheses and predictions, and design an experiment to test them; evaluate the fit between empirical data and the predictions of an hypothesis; interpret the statistical and biological significance of experimental results and observations.

• “Community and communication”:
  ....disseminate biological information in a variety of written formats; communicate and integrate biological information effectively one-on-one and in small and large groups; operate with integrity and an awareness of the responsibilities of a biologist and their own limitations.

• “Critical Thinking”:
  ....identify when a publication follows the scientific method and summarize the key conclusions of biological studies by critiquing and evaluating their results and conclusions.
1. Discuss, analyze and **critique** published primary research articles in biology.

2. **Design a study** aiming at answering a biological question and **write** in plain terms a description for the study.

3. **Assess** the design of a biological investigation written by their peers and to constructively justify their assessment.

4. **Present orally** a critique of a paper and design of a biological investigation.
Dans quelle section étiez-vous inscrit / In which section were you registered

Course Sections

Section A - Cell & Molecular Biology
Section B - Physiology
Section C - Ecology, Evolution, & Behaviour
Section D - Section bilingue - Écologie et autres
Course Activities – Fall Term

Workshops
Practical skills for assessing the science in the primary published literature and for presenting oral communications.

Student Seminars
Critique of a preselected paper. Group, class discussions provide the basis for formative feedback.

December Exam
Critique of a preselected paper.
Course Activities – Fall Term

Summative/Formative Assessments based on grading rubrics:
(weekly assignments; oral presentation; critical summary)

**Weekly Critiques**
(Formative – pass/fail)
- Scope and relevance of information
- Depth of analysis

**Oral Presentation (10%)**
(Formative/Summative)
- Presentation and visual support
- Group and class discussions provided for formative feedback

**Critical Summary (15%)**
(Formative/Summative)
- Scope and relevance of information
- Precision / Clarity
- Coherence
- Depth of analysis

*Grading rubrics*
Course Activities – Winter Term

Workshops
Designing of a Biological Investigation

Research Proposal and Seminars
Experimental design and communication
Peer-review of research proposals

April Exam
Assessment of a research proposal
Course Activities – Winter Term

Summative/Formative Assessments based on grading rubrics:
(weekly assignments; oral presentation; Research Proposal)

**Design of an Investigation (20%)**
(Formative/Summative)

1\textsuperscript{st} Draft - basis for peer-review exercise (formative feedback)

2\textsuperscript{nd} Draft (Final) – Basis for summative assessment

**Peer-Review of Proposals**
(Formative – pass/fail)

Scope and relevance of information

Depth of analysis

*Feedback shared to presenters

**Oral Presentation (15%)**
(Formative/Summative)

Quality of proposal

Value of Scientific Question

Group and class discussions (formative assessment for final draft)

*Grading rubrics
Goal: to demonstrate your abilities, individually, to evaluate and critique a published research article.

Juveniles exposed to embryonic corticosterone have enhanced flight performance
Eunice H. Chinn1,*, Oliver P. Love2,*, Jan J. Verspoor3, Tony D. Williams2, Kyle Rowley4 and Gary Burness5

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Exposure to maternally derived glucocorticoids during embryonic development impacts offspring phenotype. Although many of these effects appear to be transient ‘negatives’, embryonic exposure to maternally derived stress hormones is hypothesized to induce perinatal responses that increase survival potential for offspring in low-quality environments; however, little is known about how maternal stress influences long-term survival-related performance traits in free-living individuals. Using an experimental design of yolk corticosterone (embryonic signal of low maternal quality), we examined potential impacts of embryonic exposure to maternally derived stress on flight performance, wing loading, muscle morphology and muscle physiology in juvenile European starlings (Sturnus vulgaris). Here we report that fledglings exposed to experimentally increased corticosterone as late performed better during flight performance trials than control fledglings. Consistent with differences in performance, individuals exposed to elevated embryonic corticosterone fledged with lower wing loading and had heavier and more functionally mature flight muscles compared with control fledglings. Our results indicate that the positive effects on a survival-related trait in response to embryonic exposure to maternally derived stress hormones may balance some of the associated negative developmental costs that have recently been reported. Moreover, if embryonic experience is a good predictor of the quality or risk of future environments, a perinatal phenotype associated with exposure to apparently negative stimuli during development may be adaptive.

Keywords: yolk hormones, corticosterone, embryonic stress, flight performance, survival, European starling.
• Supports **Program Goals** (scientific method & scientific literacy) and promotes **Interdisciplinary** learning and **Interpersonal** skills (diplomacy) small collaborative student research teams

• **Communication** Skills - development of oral presentations, compilation of an extensive literature review in an Integrated Report, formulation of constructive feedback critiques, online weekly updates

• **Synthesis & Evaluation** - this research seminar course supports a **holistic approach** with an emphasis on collaborative discussions that is application based.

Magner 1990, Sounders 1993
Research Seminar Teams

Vitamin D & Cancer Prevention
Organic Foods – are they healthy?
Herbal Remedies - are they safe?
BPA & Environmental Issues
Vaccines & Autism
Climate Change & Disease
## Grading/ Evaluations

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Seminar Proposal Presentations</td>
<td>15%</td>
</tr>
<tr>
<td>Constructive Feedback</td>
<td>10%</td>
</tr>
<tr>
<td>Seminar Presentations</td>
<td>25%</td>
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<tr>
<td>Learning Tools</td>
<td>10%</td>
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<tr>
<td>Final Integrated Reports</td>
<td>30%</td>
</tr>
<tr>
<td>Student Participation</td>
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Evaluation Forms & Rubrics

Please refer to handouts...

- Research Seminar Proposal Presentation Assessment Criteria
- Constructive Feedback for Research Seminar Proposal Presentations
- Research Seminar Presentation Assessment Criteria
- Constructive Feedback for Research Seminar Presentations
- Research Team Learning Tool
- Final Integrated Report Evaluation Criteria
Benefits

• Ties concepts together in one large integrated project

• Encourages students to work as a team, by analyzing the facts, formulating solutions, predicting consequences

• Links to Bloom’s Taxonomy

  Evaluation
  Synthesis
  Analysis
  Application
  Comprehension
  Knowledge
Capstones in Science

“Hone professional competencies for research investigations, scientific literacy, communication, and critical thinking in preparation for their careers as professionals in any science related field”.

- Analysis of primary literature
- Critiquing
- Designing research proposals
- Communication (interpersonal skills, oral, written)
Bibliography


