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

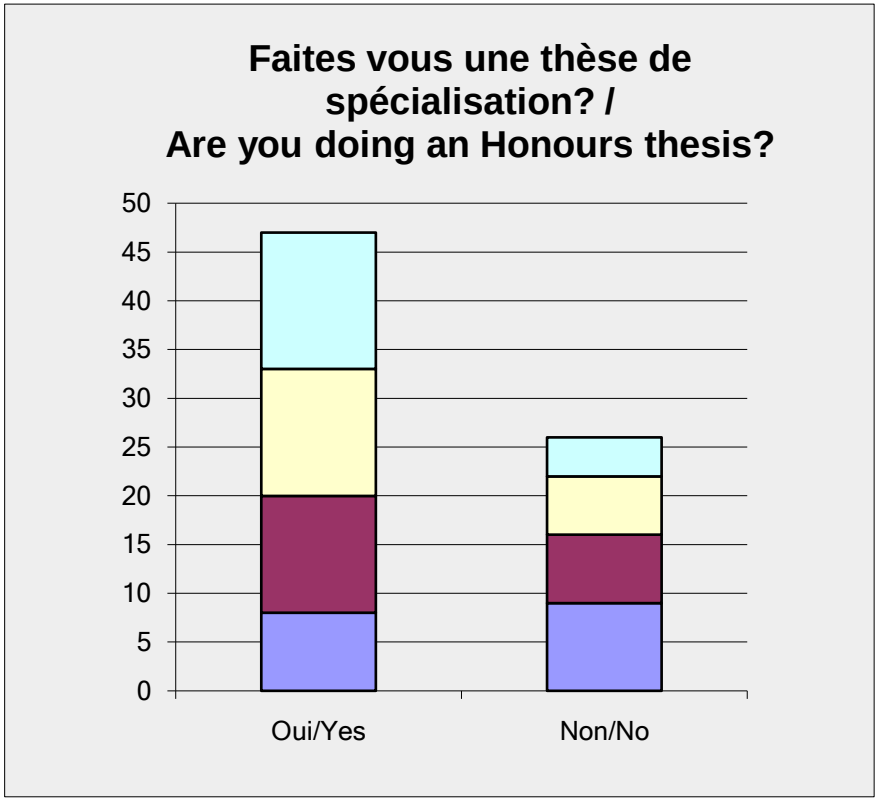
- **Context:**
  - Program Outcomes
  - Course Outcomes
  - Activities & Assessments
  - Enrolment (student population)

- **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



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.

Course Learning Outcomes

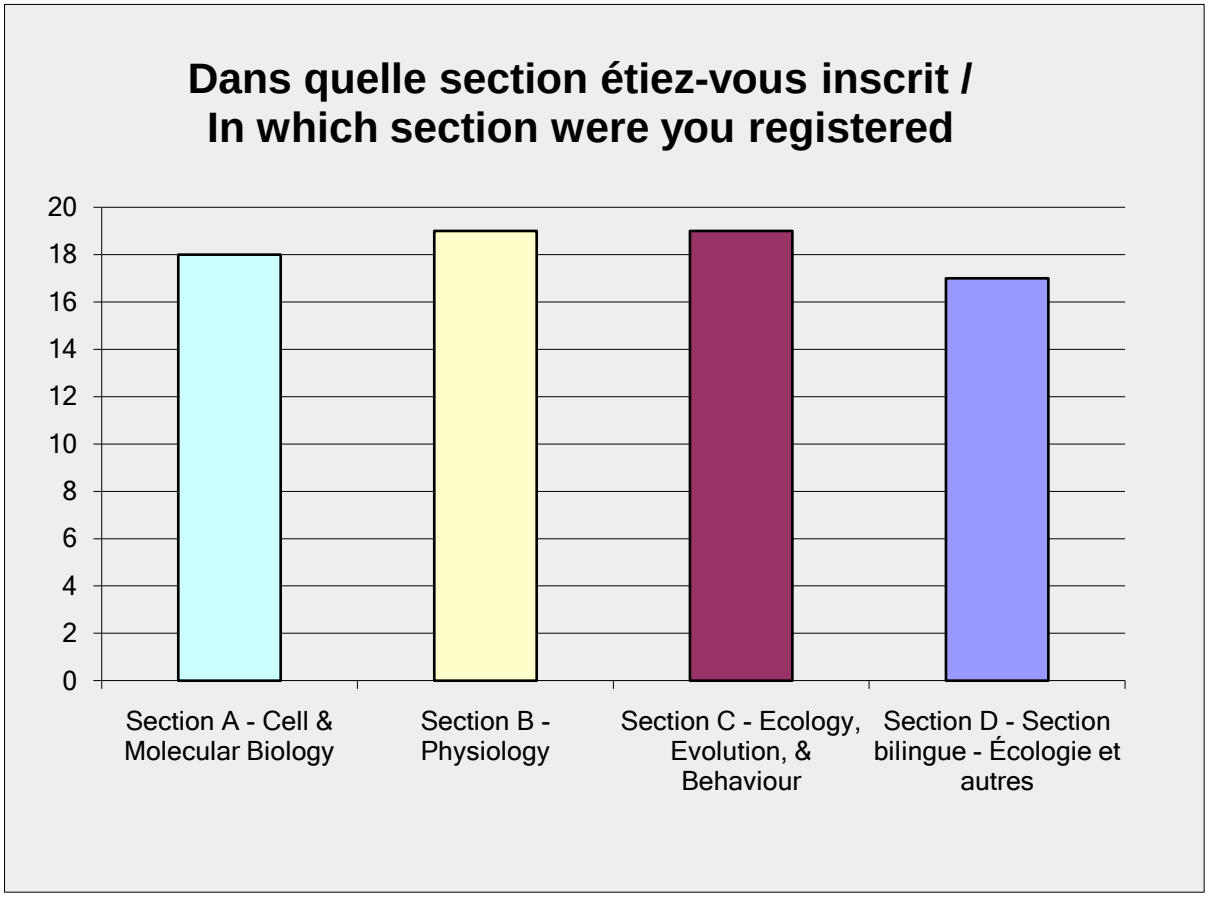
1. Discuss, analyze and **critique** published primary research articles in biology.

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

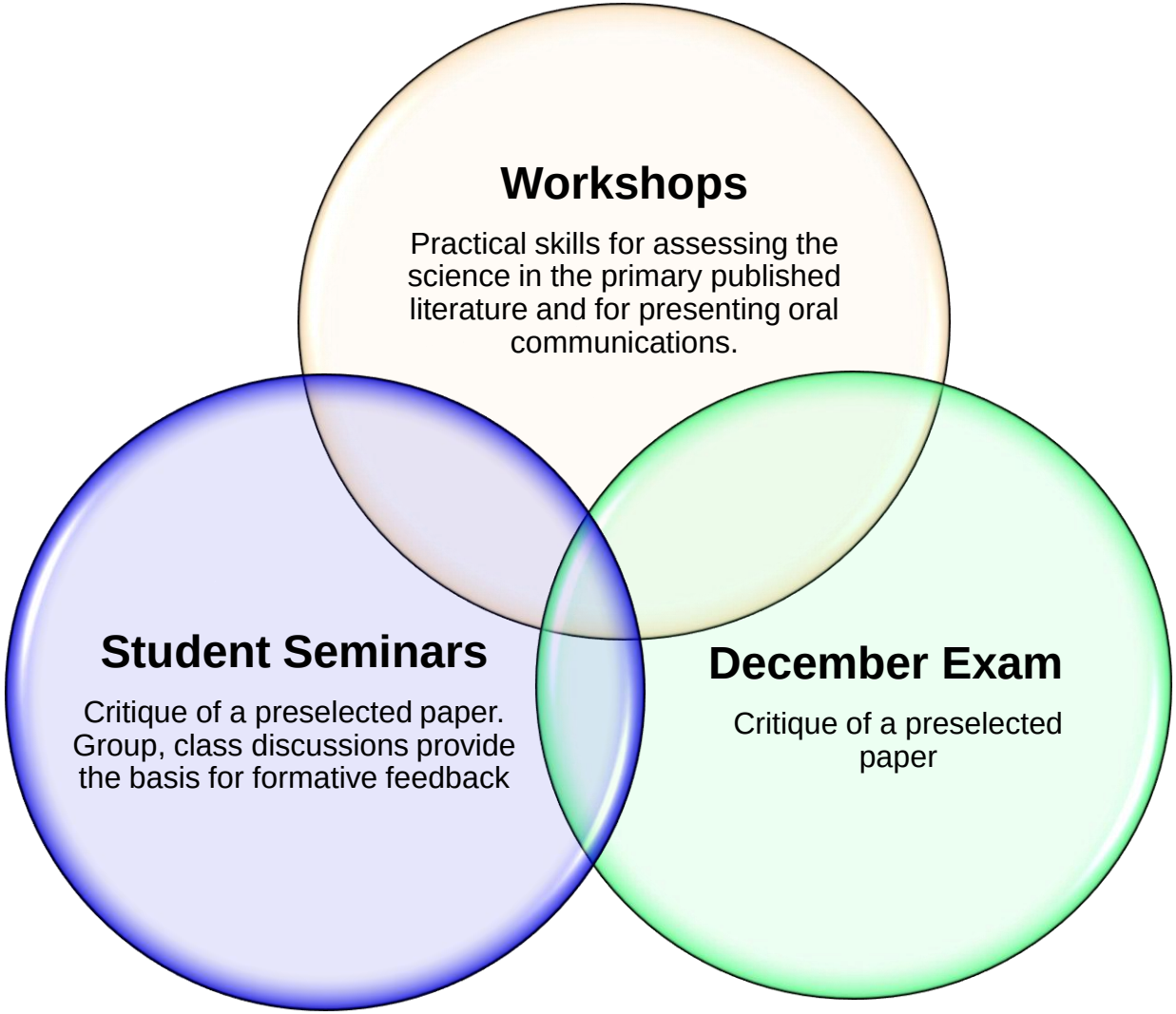
3. **Assess** the design of a biological investigation written by their peers and to constructively justify their assessment.

4. **Present orally** a critique of a paper and design of a biological investigation.

Course Sections



Course Activities – Fall Term



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

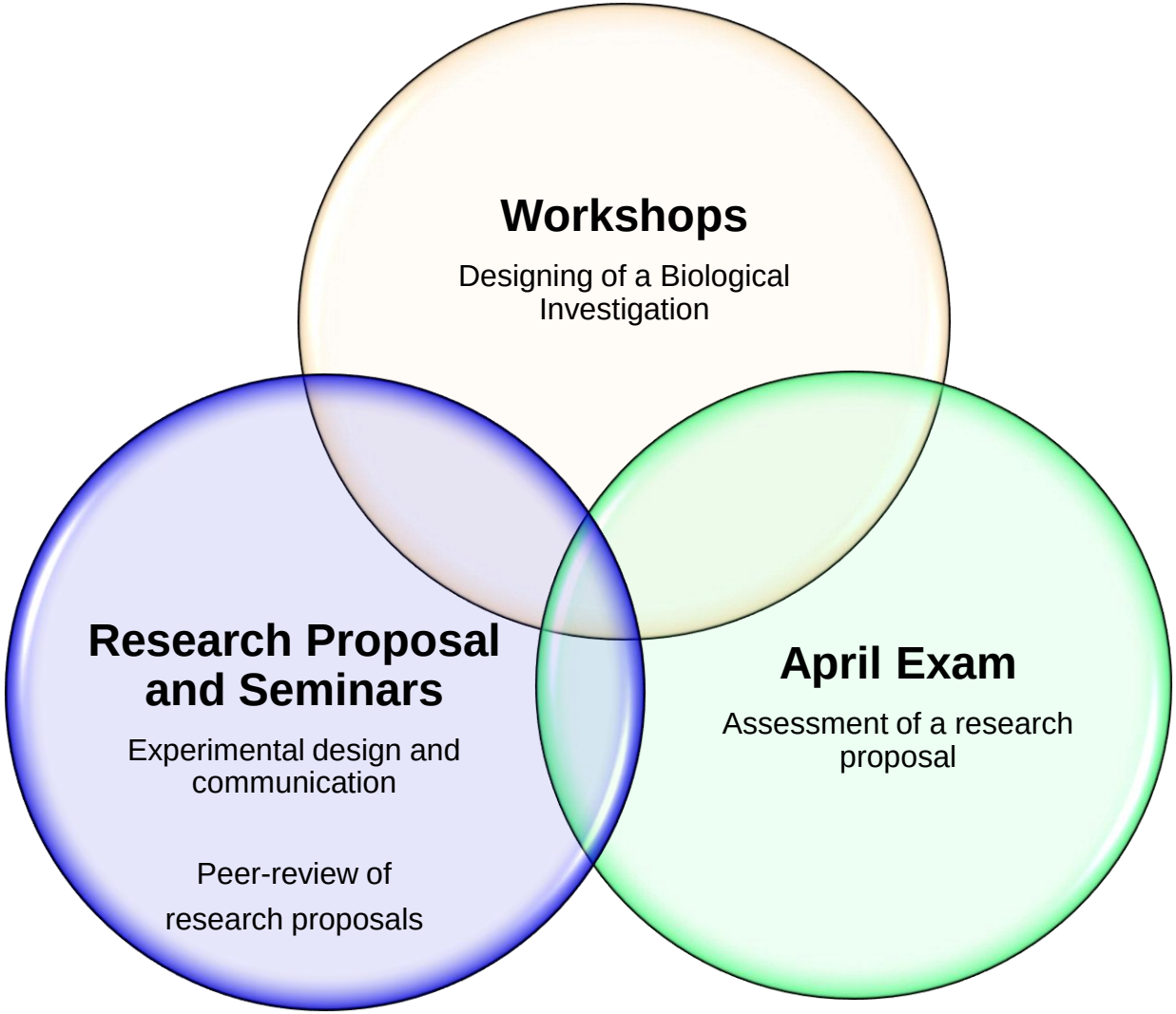
Precision / Clarity

Coherence

Depth of analysis

*Grading rubrics

Course Activities – Winter Term



Course Activities – Winter Term

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

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

1st Draft - basis for peer-review exercise (formative feedback)

2nd 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

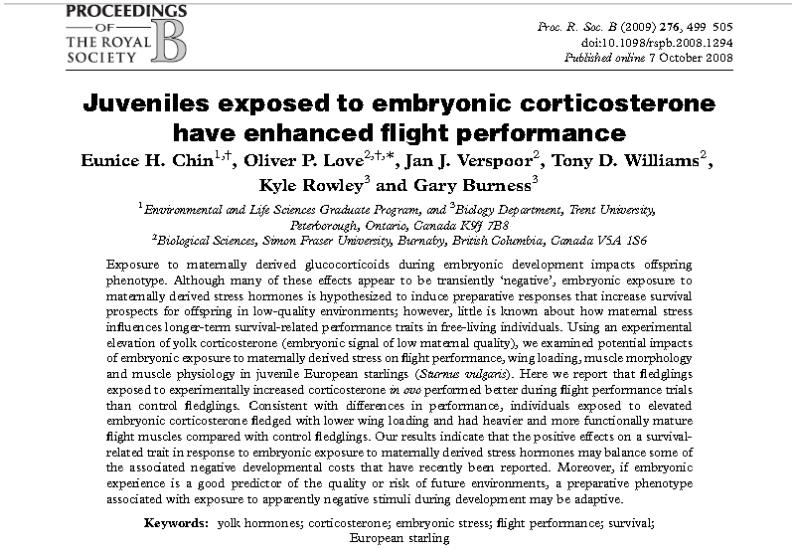
Group and class discussions (formative assessment for final draft)

*Grading rubrics

COURSE ACTIVITIES - EXAMS

1) December Exam: 25%

Goal: to demonstrate your abilities, individually, to evaluate and critique a published research article



PROCEEDINGS OF THE ROYAL SOCIETY B

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Juveniles exposed to embryonic corticosterone have enhanced flight performance

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Exposure to maternally derived glucocorticoids during embryonic development impacts offspring phenotype. Although many of these effects appear to be transiently 'negative', embryonic exposure to maternally derived stress hormones is hypothesized to induce preparative responses that increase survival prospects for offspring in low-quality environments; however, little is known about how maternal stress influences longer-term survival-related performance traits in free-living individuals. Using an experimental elevation 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 *in ovo* 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 preparative phenotype associated with exposure to apparently negative stimuli during development may be adaptive.

Keywords: yolk hormones; corticosterone; embryonic stress; flight performance; survival; European starling

2) April Exam : 25%

Goal: to demonstrate your abilities, individually, to evaluate and critique the design of a biological investigation

LIFE SCIENCES 4L03

Advanced Research Seminar Course

- 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

Seminar Proposal Presentations	15%
Constructive Feedback	10%
Seminar Presentations	25%
Learning Tools	10%
Final Integrated Reports	30%
Student Participation	10%

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".

- **A**nalysis of primary literature
- **C**ritiquing
- **D**esigning research proposals
- **C**ommunication (interpersonal skills, oral, written)

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