New Graduate Course Proposal Form

Faculty of Science

The following information is required for all new course proposals. Provide evidence of consultation, where appropriate. To facilitate the review/approval process, please use the headings below (and omit the italicized explanations below each heading).

All new course proposals must include a library statement.

**1. Graduate Program:** BIOLOGY

**2. Responsible Unit:** Faculty of Science, Department of Biology

**3. Subject Code (Rubric) and Course Number:** GS/BIOL 5150

**4. Credit Value:** 1.5

**5. Long Course Title:** Critical skills for meta-analyses and systematic reviews

**6. Short Course Title:** Critical skills for meta-analyses and reviews

**7. Effective Term/Calendar Year:**

Fall 2022

**8. Language of Instruction:**

English

**9. Calendar (Short) Course Description:**

Scientific synthesis of all academic evidence from data sources to published papers promotes evidence-informed decision making. Every discipline, from molecular biology to evolutionary biology, can benefit from advanced use of synthesis tools. This course develops a set of tools to support innovation and to leverage evidence through meta-analyses and systematic reviews.

**10. Expanded Course Description:**

**The course is developed and published in full here as an open, free e-book reader:**<https://bookdown.org/chris/quantitative_synthesis_tools/>

**Outline**

1 Introduction to synthesis in science: Examine the scope and extent of synthesis in contemporary science for many disciplines.

2 Quantitative synthesis tools: Explore conceptual and mental models for synthesis.

3 Evidence workflow reporting: Develop reporting documentation from a formal synthesis review process.

4 Meta-analysis in R: Develop a template for derived data for analyses, and complete a meta-analysis in R.

5 Interpretation of meta-analyses: Examine model outputs from meta-analyses and interpret. Identify key components.

6 Coursework: A summary of the steps needed to complete summative assessment including rubrics

**11. Course Learning Outcomes:**

Critically review peer-reviewed journal publications.

Engineer syntheses and solutions from published evidence.

Understand strengths of different synthesis tools and reporting.

Do a meta-analysis or systematic review.

**12. Rationale:**

Scientific synthesis of published evidence in all disciplines is a critical professional skill as an academic. This course consolidates critical thinking in reading the work of others, reusing evidence, and addressing open and more inclusive, diverse science because transparency in scientific reporting is paramount to progress and evidence-informed science. This is a strongly interdisciplinary course that takes a deep and wide big-picture view of scientific evidence and how it can be combined through synthesis.

Many offerings in the Biology graduate program currently examine advanced discipline-specific topics including GS/BIOL5027 Topics in Molecular Biology I: Gene Expressions, GS/BIOL 5028 Topics in Molecular Biology II: Proteins, GS/BIOL 5088 Advanced Topics in Ecology and Evolution, GS/BIOL 5098 Conservation Biology, and GS/BIOL 5128 Current Topics in Comparative and Integrative Animal Physiology to name a few. However, there is a need to develop advanced quantitative critical thinking skills. This proposed course in meta-analyses and systematic reviews does not overlap with advanced topics courses although the latter may include individual assignments to write short literature reviews or to critique a published paper. This offering augments all these offerings because it enables general framing and provides widely-applicable tools to evaluate the relative strength of evidence in any published literature. It also extends GS/BIOL 5081 Intro. To Biostatistics that focuses on establishing strong skills in R and open biostatistical analyses. This course consolidates statistical thinking and reason for the sciences. Finally, it does not overlap with the focussed critical skills offerings such as GS/BIOL 5100 Critical Skills in Animal Physiology or GS/BIOL 5086  Critical Skills in Ecology and Evolution that focus more specifically on these fields of study and effective oral and written communication. It consolidates principles but does not overlap with the tools developed in GS/BIOL 5144 Computer Programming for Experimental Psychology.

In summary, the current graduate curriculum provides a strong set of learning materials in specificity with biostatistics, computation, and the advanced topics, but this course provides opportunities to broadly evaluate interdisciplinary scientific evidence using contemporary powerful tools. All theses contain a critical review of literature, and with training from this course, these chapters could include meta-analyses for publication in peer-reviewed journals. Importantly, it brings new skills/pedagogy to the curriculum by teaching students how to reuse published literature for reproducible and quantitative science to inform decision making in all fields of science.

**13. Evaluation:**

Three summative exercises are associated with successful completion of this course.

**Assignment 1: evidence maps**

Design an ‘evidence map for evidence gaps’ or ‘evidence map as a geographic map’ for a topic of your choice in your expertise or domain of research.

**Learning outcomes**

Develop a checklist for reading systematic reviews and meta-analyses.

Document a quantitative synthesis process.

**Critical skills**

In this first assignment, skills developed include being able to transform your research expertise into formal scientific evidence and to synthesize peer-reviewed science papers. The checklist will adhere to common synthesis standards also enabling students to compare their work to published examples of synthesis workflows in all fields that publish synthesis science papers.

**Total value 30%**

**Assignment 2: ignite commentary**

Based on your synthesis work completed in product 1, provide a short < 2000 word Ignite format contribution appropriate for the journal Oikos that inspired this format of contribution to science.

**Learning outcomes**

Consolidate understanding of key synthesis elements from the literature.

Effectively community in writing trends in a field of scientific research.

Practice writing succinctly and directly.

**Critical skills**

In this second assignment, skills development scaffolding upon existing works and lessons developed earlier in the course. The evidence that students reviewed is then described in a short, direct paper refining their writing skills. A critical skill in science is being able to communicate directly, clearly, and in brief, key trends and gaps in research and what we know in science. This assignment directly supports refinement of communication and high-level synthesis thinking that is big picture and accessible to a wide readership.

**Total value 25%**

**Assignment 3: meta-analysis**

Complete a meta-analysis in R for a subset of your studies.

**Learning outcomes**

Format data for meta-analyses in R open source programming language.

Explore the capacity of the R package metafor to synthesis derived data from papers.

Pilot statistics for a dataset.

**Critical skills**

In this final assignment, students test the trends identified in the first two assignments with simple, high-level meta-analytical statistics. In doing so, students explore the free, open source programming language R, develop critical thinking skills for statistical evidence from syntheses by identifying key statistics and measures, and develop their own code that can be applied to their own work and theses.

**Total value 45%**

**14. Integrated Courses:**

This course will not be integrated into the undergraduate program.

**15. Cross-listed Courses:**

This course will not be cross-listed initially, but if there is strong interest from other related graduate programs (e.g., Kinesiology, Psychology), this will be considered.

**16. Enrolment Notes:**

This course is open to all students enrolled in the Biology graduate program at MSc or PhD. It is recommended that students take this course once they have developed their thesis research proposal.

**17. Faculty Resources:**

Qualifications needed to teach this course include expertise in statistics, familiarity with meta-analyses and systematic reviews, experience with peer-reviewing and critical thinking, and familiarity with the R programming language. There is no impact on teaching resources at the departmental level.

**18. Physical Resources:**

No specific classroom or infrastructure is needed. The programming language used to do analyses is open, free and available on all major computer operating systems. A computer lab is not needed and personal laptops or computers used for primary research in student labs are sufficient.

**19. Bibliography and Library Statement:**

**All readings are published in peer-reviewed journals accessible through the York University library system.**

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McKinnon, M. C., S. H. Cheng, R. Garside, Y. J. Masuda, and D. C. Miller. 2015. “Sustainability: Map the Evidence.” Journal Article. Nature 528: 185–87.

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Page, Matthew J., Joanne E. McKenzie, Patrick M. Bossuyt, Isabelle Boutron, Tammy C. Hoffmann, Cynthia D. Mulrow, Larissa Shamseer, et al. 2021. “The PRISMA 2020 Statement: An Updated Guideline for Reporting Systematic Reviews.” Journal Article. BMJ 372: n71. https://doi.org/10.1136/bmj.n71.

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