Introduction
Grant MacEwan University is an undergraduate university offering a BSc degree in which students may major or minor in Biological Sciences. Research Techniques in Molecular Biology (Genetics 420) is a fourth-year laboratory course offered for the first time in 2011-2012. Students attend two 3-hour lab periods each week in both the fall and winter terms for a total of 120 instructional hours. These senior undergraduate students are mentored in a small class setting with a maximum enrollment of 12 students. In addition to bench work, each lab period includes discussions of theory related to techniques as well as information literacy and scientific writing. Critical thinking and problem solving are emphasized. This is an academically rigorous course that develops both scientific literacy and technical skills.

Learning Objectives
At the end of this course, students should be able to …
- Perform a wide variety of methodologies commonly used in molecular genetic analyses and discuss the principles underlying techniques that have been employed
- Keep a comprehensive laboratory notebook outlining experimental setup, protocol details and data collected
- Analyze experimentally collected data
- Evaluate, integrate, and apply information to plan experiments, troubleshoot experimental difficulties and discuss experimental outcomes
- Effectively communicate scientific ideas orally and in written form

Fall Project: Cloning, Mutagenesis and Purification of EGFP
This project focuses on techniques used to create recombinant DNA constructs for the expression and analysis of proteins. Each student proposes a specific mutation to an enhanced green fluorescent protein (EGFP) and predicts how it will alter the proteins function, using the existing literature. EGFP is cloned into an expression vector then mutated using site-directed mutagenesis. The mutated protein is then expressed, quantified, characterized and compared to the wild type EGFP.

Winter Project:
γ-Globin Expression in K562 Cells
This project focuses on methods to analyse gene expression. K562 cells can be induced to differentiate into hemoglobin producing cells. Students review the literature to identify chemicals known to induce differentiation. Students independently culture cells, testing their chemical alone and in combination with glutamine deprivation. Cell proliferation is monitored, differentiation is quantified, and γ-globin expression is observed.

Assessments of Learning
Both summative and formative assessment are utilized with a variety of assessments and scaffolded assignments. All written assignments are assessed using detailed rubrics which are provided to students in advance.

Examinations – Fall & Winter
- Written examination; short and medium answer questions
- Emphasizes critical thinking and problem solving skills by asking students to apply knowledge to new experimental situations
- Assesses acquisition of theoretical knowledge

Techniques
- Cell culture and manipulation
- Differential cell staining
- Solution preparation
- RNA and protein extraction and quantification
- RT-PCR
- Real-time PCR
- Northern analysis
- Western analysis

Methods
- First, a detailed outline is evaluated
- Second, a draft is evaluated
- The final literature review is submitted at the end of the fall semester

Research Proposal – Fall
- Builds on the research proposal
- Describes the use of GFP in research, emphasizing the link between its structure and function as a fluorescent marker
- First, a detailed outline is evaluated
- Second, a draft is evaluated
- The final literature review is submitted at the end of the fall semester

Research Proposal – Winter
- Includes a brief literature review to provide rationale for the proposed chemical inducer
- Identifies the catalog number and an assessment of chemical affordability and availability using the manufacturer website
- Provides a Health & Safety summary using the MSDS
- Includes a protocol for making a stock solution

Laboratory Notebook – Fall & Winter
- Includes:
  - Explanation of the purpose and theory of the experiment
  - Predictions of expected results, based on theory
  - Complete details experimental procedures
  - Results, accompanied by analysis and interpretation
  - Checked at the beginning of each lab to ensure students are prepared
  - Assessed at the end of each semester

Conclusions
This course provides an excellent opportunity for students to develop a variety of skills needed for a career in science. The progress made by students in this course demonstrates its success – by the end of the winter project, students are able to work independently and thoughtfully analyze their results. Student feedback has indicated that students feel this has been one of the most valuable course experiences of their degrees.

References