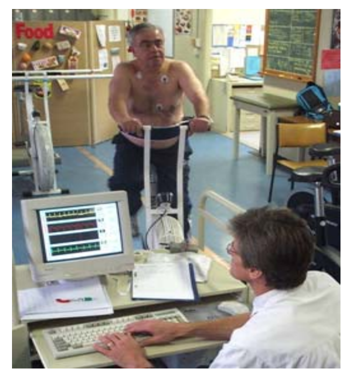
PROBLEM SOLVING STANDARDS – BIOMEDICAL SCIENCES

Adapted from the AAC&U VALUE Rubrics and acknowledged with thanks. See Assuring Graduate Capabilities

Definition: Problem Solving is the process of designing, evaluating and implementing a strategy to answer an open-ended question or achieve a desired goal.
VU Grad Cap Definition: Problem solve in a range of settings

Novice to Expert categories	Competent	Novice	Beginner
	Graduates of this **course** can	Students in the **middle stages** can	Students in the **early stages** can
VU Grad Caps matrix definition	P5 – Identify and solve a broad range of complex problems, drawing on in-depth knowledge, understanding, reflection and evaluation	P4 – Identify and solve complex problems, selecting from a range of strategies and drawing on broad knowledge and skills.	P3 – Identify and solve problems through the application of broad knowledge and skills.
Define Problem/Hypotheses	Clearly define complex and interrelated problems requiring critical analysis. Source, identify and discern relevant sources of information. Conduct advanced literature researching, using scientific databases. Write a clear, concise, precise and novel hypothesis.	Given a physiological problem, source, identify and review appropriate scientific resources and define specific aims/hypotheses.	Understand and apply basic scientific principles (e.g. hypothesis formulation, mechanisms of physiological actions and scientific reasoning.
Identify Strategies/Methodologies	Understand and integrate complex mechanisms of physiological actions. Integrate prior knowledge with newly-synthesized information to identify a range of appropriate strategies. Design a complex experiment to test a hypothesis. Incorporate human, animal and scientific ethics. Undertake experimental work with accuracy, reliability and a logical sequence.	Under facilitation, display a capacity to apply scientific reasoning and appropriate experimental design. Assess the quality of the proposed experimental methodology. Apply appropriate experimental design to the problem-solving process.	Understand and apply basic knowledge of hypothesis testing, experimental design (control and experimental groups), sources of error, validity, reliability and calibration, units of measurement, medical terminology, laboratory skills, occupational health & safety rules and following a written method precisely.
Analyse Evidence/Results	Explain differences in expected versus observed data with appropriate justification. Design experiments and analyse data using complex statistical approaches (e.g. 2 way ANOVA with repeated measures). Critically analyse alternative solutions and select the most appropriate, using a clear rationale.	Undertake more technically advanced laboratory skills. Undertake more complex statistical analysis (e.g. ANOVA, time series, probability, cause and effect interactions). Use a more complex approach to laboratory/scientific report writing. Analyse results in the context of normal and abnormal, expected and unexpected ranges for physiological parameters.	Collect data by accurate observation. Analyse and describe raw and summarised data accurately. Present results in a variety of formats (e.g. types of graphs). Undertake basic descriptive statistical analysis (e.g. means and standard deviations, $p<0.05$). Use a standardised approach to laboratory report/scientific writing (e.g. ensuring accurate reporting of observations).
Interpret Findings/Discussion	Draw correct conclusions from results, ensuring an absence of internal inconsistencies and accounting for unexplained results. Relate results to hypotheses and to current theories. Recognize the limitations of current methodologies. Propose solutions based on a cohesive and justified argument derived from scientific evidence and multi-disciplinary knowledge.	Evaluate findings using a more complex scientific approach. Draw conclusions relating to the hypotheses, noting where they do not fit. Apply further rigor and critical analysis to the experimental data. Apply knowledge of complex mechanisms to physiological actions.	Evaluate findings using a standardised approach. Make basic interpretations of findings. Relate findings to published research literature.
Reflect on outcome of strategies	Apply a range of strategies to more complex problems. Design new problem-solving strategies and evaluate their effectiveness.	Reflect on improved problem-solving strategies. Identify the most effective strategies, evaluate ability to employ problem-solving techniques and suggest improvements.	Reflect on effectiveness of problem-solving strategies with guidance. Identify gaps in knowledge and self-improvement requirements.

Exemplars	Unit: Advanced Experimental Techniques Co-ordinator: Dr Kerry Dickson	Cardiorespiratory & Renal Physiology Co-ordinator: Dr Alan Hayes	Foundations for Biological Sciences B Co-ordinators: Dr Patrick McLaughlin, Dr Crispin Dass
Aim	This subject aims to make students into scientists by developing their skills in the following areas: problem solving, independent thought, experimental design, data collection, interpretation of findings, and 'hands on' laboratory skills. Students are taught standard laboratory techniques include animal surgery, sterility, processing of tissues for microscopy; immunohistochemistry, florescence, electrophoresis, PCR, immuno-blotting and bioinformatics.	The subject explores more advanced functional aspects of the cardiovascular, respiratory and renal systems. Exercise is used as a natural stressor of these systems to allow students to apply their knowledge and show the integration of these systems. Further applied situations, such as thermoregulation and high altitude are also covered. Students are also introduced to current computer-based methods for measuring human function in a series of simulated medical specialist tests.	This subject enables students to acquire the skills and techniques required to critically analyse written material, particularly scientific reports and to analyse scientific data. Topics include: basic mathematical principles, scientific notation and SI units, biophysics, introduction to data; descriptive statistics; introduction to probability; normal distribution; the t statistic; hypotheses testing and 'p' values. Use will be made of statistical and other computer packages used within Biomedical Sciences.
Assessment	Students are required to design a project and submit an application for funding to a hypothetical granting body. The grant proposal, which is worth 40%, must use an animal model to localise and quantify an antigen of interest (e.g. protein) in an organ using the technique of immunohistochemistry. Using original scientific articles, students are required to show that they understand the theory behind these techniques and that they can adapt these techniques to the novel research question that they have proposed. The grant proposal consists of Summary and Significance, Ethics, Budget, Aims, Background, Experimental Design and Research Plan (Animal Husbandry, Animal Surgery, Tissue Preparation, Primary & Secondary Antibodies, Enzyme Conjugate & Substrate Chromagen, Quality of Staining, Analysis of Staining & Statistical Analysis). Given an area of physiology (fetal development), the student must brainstorm to find an area of interest that has an unanswered question. They design an individual experiment (i.e. differs from all other grant applications) which investigates the effect of at least 2 factors (e.g. placental insufficiency) on fetal development across several stages of pregnancy. They must adapt the knowledge that they have gained in the subject (e.g. animal surgery) to their particular research question. This requires a high level of critical thought and problem solving. 	In the first assessment task, worth 20% of the total mark for this subject, students are required to answer multiple choice questions, where the answer counts for 2 marks and the remaining 8 marks are assigned to an explicit explanation as to why the students consider the answer to be correct and the other options incorrect. The questions relate to key learning concepts and require the students to draw on unit content, as well as an exploration of relevant scientific sources. The objective is to demonstrate to students, the importance of being able to understand and address specific aspects of problem-solving and how to approach questions in a logical way. In a second assessment task, students are asked to submit a written report as a specialist to a patient's doctor, about the preparedness of a patient to withstand the rigors of surgery. The assessment is worth 20% of the total assessment of this subject. Students work in pairs or groups of three to obtain results in practical classes which test the patient's cardiovascular, respiratory and renal responses to various stressors, including exercise. 	The assessment in this subject includes two Maths assessment tests, a Biophysics test, a Statistics skills test and an assignment. In the assignment, which contributes 25% of the total mark for this subject, students are only allowed to use scientific literature (journal articles only, no text books) for fact finding and all sources must be referenced using the Harvard system of referencing. Some questions (of the non-maths variety) may have more than one correct response, so students are required to ensure that their answer is supported by proper argument and if required, backup literature. In this assignment, students are required to show that they can summarize information, critically review the presentation of data and methodological approaches, understand scientific terms, make calculations and use appropriate units. For example, students are asked to critically analyse data presented in a range of forms, (e.g. list good and bad things about the graph below).