Objective: The objective of this module is to ensure that all students understand the meanings of mechanistic hypothesis and mechanistic experimental design. First, we will cover how hypotheses are generated, paying close attention to the need to understand the relevant literature at a level that enables one to draw conclusions, i.e. utilize deductive reasoning. The ability to draw conclusions is what enables one to construct hypotheses. The next stage will be to consider ways to address hypotheses experimentally. Sub-stages include: 1) focusing the question into small manageable bits that allow step-by-step experimentation; 2) proposing ways to answer “how”; 3) developing approaches to validate the findings; 4) considering experimental models that are feasible and that reveal mechanisms rather than provide further description; and 5) evaluating ways to utilize in vitro and in vivo complementary models that are relevant to the question. Finally, we will cover how to re-assess the problem and determine if additional validation experiments are required. Critical evaluation of results is one of the most important parts of experimentation---Think “prove it!” Remember, the initial experimental plan should be regarded as a rough map that should be modified as data are generated. It is expected that your experiments will take you into uncharted waters, and therefore, new unexpected findings should be responded to by dynamically modifying the plan to better address the original hypothesis.

Goal: Teach all students to think mechanistically and learn the difference between study and experiment.

At the conclusion of this module, the goal of ensuring that all students recognize whether their own or someone else’s proposal is hypothesis-driven and mechanistic will be met. In addition, the students will learn to be fearless about the concept of recognizing flaws in research direction, and modifying their approaches, and possibly even their questions, to effectively maintain a mechanistic experimental design.

Module 3 Schedule

Session 1: Participant introductions and brief description of on-going, planned, or desired research. Individual participant’s perceived definition of “hypothesis” and “mechanistic”. Open discussion with examples. Short quiz to see of students recognize hypotheses and mechanistic experiments.

Session 2: Scoping the literature—how to approach the volume and not get overwhelmed. How to spring-board off the PI/Mentor’s research program rather than be used as a vehicle for their projects.

Session 3: Students will be given the opportunity to review narrow topics (before coming to class) and generate one deductive conclusion and one hypothesis. Break out groups will enable students to discuss their ideas. Final presentation with open class critique/discussion

Session 4: Students will be given a choice of projects and in small groups, generate a series of step-by-step experiments that could be used to mechanistically address the major question. Consider the potential need to add descriptive experiments if information is not sufficient.
Session 5: Design of parallel and complementary in vitro and in vivo or human experiments. Students will learn how to take advantage of different models to address questions mechanistically while considering their potential pitfalls and limitations.

Session 6: Learn how you know when you’re done, and what additional experiments and studies are needed to mechanistically address your hypothesis within a reasonable period of time. Not all questions can be answered to perfection, but the new information should lead to another wave of hypothesis generation.

Learning Strategies:
The class sessions will have didactic, class-wide interactive, small group discussion, and brief student presentation components. Open discussion and questioning will be encouraged. Quite suggestions/criticisms will be encouraged for those who wish to remain anonymous.

Evaluation:
Although no grades will be given, each student will be given an evaluation to individualize the learning process, pointing out areas of excellence as well as need for improvement. Overall growth from the start to completion of the module will be noted. At any point during the module, the student, senior scholar, or faculty leader may request private discussion to accelerate progress or solve potential problems.