Bioengineering Day Poster Addendum

1. List two to four **Desired Needs** of your project that led to your final design objectives.
   - Need for organ-specific metabolic information: Traditional biochemical assays often homogenize tissues and lose organ-level information, so our project aimed to preserve tissue structure while comparing rapamycin effects across distinct Drosophila organs.
   - Need for a non-destructive, molecular-level metabolic readout: We needed an imaging/spectroscopy workflow capable of detecting major biomolecular signatures such as lipids, proteins, water, and deuterium-labeled newly synthesized molecules without requiring fluorescent labels or destructive extraction.
   - Need for quantitative and reproducible Raman spectral comparison: A major design need was to create a workflow that could produce quantitative, reproducible Raman spectral comparisons between control and rapamycin-treated samples. This led us to use standardized spectral preprocessing and ratio-based metrics such as, lipid/protein, lipid CD/CH, protein CD/CH, and lipid unsaturation ratios.
2. List the major **Constraints** on your design/project
   - Safe handling of rapamycin, D_2O, solvents/fixatives, glass slides, dissection tools, and laser-based Raman instrumentation.
   - High fly mortality, damaged organs during dissection, sample degradation and contamination, inconsistent Raman signal quality, limited Raman instrument availability, and difficulty interpreting broad Raman signals as specific metabolites.
3. List the major **Engineering Standards** on your design/project
   - OSHA Laboratory Standard 29 CFR 1910.1450: The workflow required handling rapamycin stocks
   - ANSI Z136.1: The use of high-intensity laser sources
   - CDC/NIH BMBL guidance: For biological sample handling
4. Explain **Ethical, Environmental, or Societal concerns** for practical applications of your project.
   - This project requires responsible chemical, biological, and laser-safety practices when handling rapamycin, D_2O, Drosophila tissues, glass slides, and Raman/SRS imaging systems. Environmentally, waste should be minimized and disposed properly. Societally, Drosophila results should not be overstated as direct evidence for human rapamycin treatment.
5. Describe **Active Teamwork** and **Leadership** in your design group
   - Our team divided tasks based on strengths and availability. Adam led most imaging sessions, while Shuo led figure preparation and data analysis; both members contributed to dissections. When opinions differed, we discussed the issue, compared figures, and used references to support decisions. We tracked deadlines through calendars and text messages, and improved our workflow through constructive feedback from Dr. Shi and TA Yashwin.
6. What were the most significant motivating factors that led you to acquire new knowledge, be self-initiating, and persist against challenges and setbacks.
   - Our strongest motivations were curiosity about how rapamycin changes metabolism in specific Drosophila organs and the sense of accomplishment after seeing usable Raman data emerge from our experiments. This pushed us to learn Raman spectroscopy, spectral preprocessing, metabolic ratio analysis, and Drosophila dissection. We self-initiated troubleshooting when facing noisy spectra and variable tissue quality, which motivated us to refine the workflow.
7. What are your most **innovative and/or entrepreneurial ideas** for this project
   - Our most innovative idea is incorporating D_2O isotope labeling as a non-destructive metabolic probe with spontaneous Raman spectroscopy. Instead of extracting or destroying tissues, deuterium incorporation allows newly synthesized biomolecules to be detected through C-D Raman signals while preserving organ structure. This creates a reusable workflow for comparing metabolic turnover between control and rapamycin-treated Drosophila organs. In the future, this approach could be developed into a scalable screening platform for aging- or metabolism-related drug studies.