# IISME Education Transfer Plan
# Final Draft

**Proposed ETP Title:** Lab Write-Up Format
**Fellow Name:** Judy Wu
**Fellow primary e-mail:** judy_wu@fuhsd.org or jbellewu@gmail.com
**Sponsor Company:** Applied Biosystems
**Mentor Name:** Dr. Frank Stephenson

**Abstract:** The purpose of this ETP is to standardize a lab write-up format for an AP Biology course. By introducing students to a common format for all labs and consistently revisiting this format through the year, I hope to clarify write-up expectations as well as develop the scientific thought process and skills associated with autonomous experimental design, lab preparation, careful data collection, objective data analysis, and clear communication of results.

**ETP Objective:**

Though students are accustomed to performing laboratory experiments in science classrooms, I believe there is not enough scaffolding to help students understand how to approach an experiment and communicate their results. Students too often view labs as following a set of pre-determined directions to achieve a pre-determined result while they fill in numbers and answer questions. I hope that implementing this common lab write-up format will help students reflect more on their laboratory procedure before and during the lab so they better understand what they are doing and hoping to accomplish. I also want students to realize that careful lab design and communication of results, which is often overlooked, often takes more time and is more integral to a successful lab than mere lab implementation. I plan to help students refine their lab write-ups throughout the year, by establishing detailed guidelines for how to present information (in graphs and tables), interpret results, and communicate conclusions. In order for students to better understand my assessment process, I also plan to implement occasional self-assessments and peer-assessments of lab write-ups based on a common lab write-up rubric so students and I have a common understanding of quality work.

I discovered this year that when each lab has different expectations and requirements, many students are confused and do not develop consistent and appropriate methods for data analysis and communication. Their lab write-ups were often incomplete, unsupported by evidence, or lacking in some other way. Without constant reference back to the purpose, hypothesis, and methods, many students were often unsure of what they were doing or even what they expected to happen. I hope to emulate the type of thought process that is authentically used in the scientific community as scientists daily explore and approach novel problems and reinforce this model throughout the year in my classroom.

**ETP connection to Summer Fellowship experience:**

I came across my ETP idea as I spoke with various teachers during the workshops that I attended as a part of my summer fellowship at Applied Biosystems. I especially appreciate some ideas from Tina Doss and Dan Raffa at Carlmont HS who explained to me how they assess their students and simulated the scientific method in their hands-on biotechnology class. Much of my lab write-up format is based on their current practices.

My summer fellowship goal is to optimize an experimental procedure, and I am experiencing first hand the type of experimental process that scientists go through as they design labs, analyze their results, develop theories and explanations, and troubleshoot when their experiments don't turn out as planned. I hope to break down this cyclical process step-by-step so students can understand the dynamic and analytical nature of "real-life" science and also practice documenting their progress through a lab write-up.

**Alignment with Standards:**

This ETP aligns well with the California Science Standards for Investigation and Experimentation and the National Board Standards. Specifically, this ETP addresses:

IE 1.b: "Identify and communicate sources of unavoidable experimental error"

IE 1.c: "Identify possible reasons for inconsistent results, such as sources of error or uncontrolled conditions"

*Each lab write-up will require students to analyze possible sources of error in their experiment as well as suggest ways to refine the experiment if it were to be repeated.*

IE 1.d: "Formulate explanations by using logic and evidence"

*This lab write-up format will constantly reinforce the need to cite evidence to support experimental conclusions in the context of the students' experience and background theoretical knowledge. Their scientific conclusions will then be assessed based on logical reasoning and clear experimental support.*

NBC Proposition #2: "Teachers appreciate how knowledge in their subjects is created, organized, and linked to other disciplines"

*This ETP will hopefully demystify the scientific thought process and help students to organize and communicate their results as professional scientists would after conducting their experiments.*

**Resources needed for ETP implementation:**

I do not need many outside resources to implement this ETP. I just need to formalize the write-up format and make sure it is applicable to all the labs I hope to implement this coming school year. This will require some advanced curriculum planning as I hope to adapt all my previous labs and labs that I'm currently designing to this format.

**The actual ETP plan:**

I plan to hand out the Lab Write-up Format during the first week of class. The guidelines will not only outline the format of the Lab Write-Up, but also explain what is expected in each section and what types of questions I expect to be answered or requirements I expect to see in each section. In order to progressively scaffold students in their usage of this tool, during the first few labs, I will give them a blank "template" to fill in to get them accustomed to the format of the lab write-up. I will also model how to approach each section and talk through examples of quality work for each section. I will concentrate on a few sections each time so that students have practice writing and refining each individual portion of the lab write-up without being too overwhelmed. As they become more familiar with the format, I will require more autonomy and initiative on the part of the students to write their own write-ups without a template to fill in. They should hold on to the lab write-up guidelines as it will be a valuable tool to refer back to throughout the year.

**Assessing and evaluating the ETP plan:**

Throughout the year, I hope to assess the success of this ETP plan both formatively and summatively. Before labs especially at the beginning of the year, I plan to give a few pre-lab quizzes in which students will be able to use their pre-lab as a "guide." If their pre-labs are complete, then they should have no trouble passing the quizzes. This will hopefully get them more accustomed to thorough pre-labs. At the beginning of the year, I also plan to discuss the lab write-up rubric with the students. A few times, I will ask them to self-assess their own write-ups based on the rubric before turning it in. I also hope to do a few peer evaluations so students have practice reading and critiquing other peoples' work. This will hopefully give them some ideas on how to improve their own writing. As students write-up labs and receive my feedback, I will expect them to compile their labs in a notebook that is to be kept in the classroom. At the end of the year, I will ask students to compare their beginning-of-the-year write-ups with their end of the year write-ups to reflect on their progress as scientific thinkers and communicators. They will then write a summary reflection or develop a short portfolio that documents how they have improved and what growth they are most proud of (of course, developing a logical and well-supported conclusion using their own work as evidence). The purpose of the write-up format after all is to give students a tool that will allow them to develop their skills as planners, detailed observers, critical thinkers, and effective presenters of scientific information.

# Lab Write-up Format for AP Bio

The purpose of this handout is to explain and clarify my expectations for the organization, breadth, depth, and quality of lab write-ups throughout the year. For future labs, you will be expected to fill in the following sections on a blank template or address the following points on your own. In case you are ever confused about lab write-up format, you can refer back to this sheet to know what to include in your lab. Good luck!

***BEFORE LAB!*** *– The key to a successful lab is clear design and careful planning. The following sections must be completed before you begin lab. If not, you will not be allowed to perform the lab in class, you will lose points on your write-up, your groupmates will have one less person to work with, and you will have to come in at a later time that is convenient for me to make up the lab.*

TITLE:
→Your title should be clear and concise and no longer than a sentence

PURPOSE:
→What is the point of your investigation? What experimental variable are you testing? What are you planning on doing? What problem are you trying to solve?

HYPOTHESIS/EXPECTED RESULTS:
→If you are performing an *experimentation* lab, make an educated guess as to what you expect to happen in the form of a testable statement. Make sure to include a "because" statement.
→If you are performing a *demonstration* lab, state the results you expect.

FLOW CHART:
→Use pictures and simple captions to describe what you will be doing in the lab. You should know the lab well enough to refer to these drawings to guide you during the lab. A peer who is familiar with the lab procedure should be able to recreate your experiment based on your flow chart.
→Simplify your procedure by honing in on the important steps. You do not need to re-write the entire procedure.

PRE-LAB QUESTIONS:
→Please answer in complete sentences in short answer form before you come to lab.
→These questions are designed to guide your understanding of the design of the lab. They are also meant to make you aware of any major pitfalls so you don't make these mistakes during lab.

DATA COLLECTION and OBSERVATIONS:
→If a data table has not been provided, please create one. Think about what you are actually measuring (temperature, volume, mass, time?). What units will you be using? How many trials?
→If a data table is not applicable, create another format for recording data.
→Leave some space for qualitative observations.

DURING LAB! **– Follow directions very carefully especially with respect to safety, use of materials, and proper clean-up. NEATLY record any quantitative data or relevant observations in the appropriate space in BLUE OR BLACK PEN! (Other colors are beautiful, but not appropriate.)**

***AFTER LAB!*** *– After you have completed your laboratory investigation, it is time to analyze your data and determine whether you can draw any conclusions. We will discuss and debrief the lab in class, but it is up to you to clearly articulate what you have learned.*

GRAPH: (if applicable)
→Remember: A graph should be able to communicate specific information standing alone!
→All graphs MUST be neat, done on grid paper (or computer), and include:

| | |
|---|---|
| Descriptive title | Labeled axes with units and appropriate range |
| Key | Lines, Bars, etc. appropriately drawn and labeled |

CONCLUSION: (REE, PE, PA)
→This is the "meat" of your write-up where you finally synthesize your results and communicate what you understand.
→The conclusion should have 3 sections (see below), each AT LEAST one paragraph long. Write in complete sentences in paragraph form, not in bullets.
→Be concise and clear. Do not include irrelevant information. Pick and choose the data that you think is relevant. More is NOT necessarily better.
→The conclusion is NOT simply a summary of your results. You should analyze your results in light of your current understanding of the topic and attempt to explain any trends and/or inconsistencies

Section 1 – **R**esults, **E**vidence, **E**xplanation:

- Describe any trends you notice in the data. Describe any major anomalies you notice in the data. Don't mention WHY yet, just WHAT.
- Refer to SPECIFIC data (qualitative or quantitative) that supports your discussion of the results.
- Did your experiment support or refute your hypothesis? If your hypothesis was refuted, why do you think this was so? If your hypothesis was supported, explore more in depth why what you observed occurred.
- Now comes the WHY. Clearly explain the thought process involved in drawing your conclusions from the data. What logical conclusions can you draw from your data?
- How does your conclusion relate to your background understanding of scientific principles?

Section 2 – **P**ossible **E**rror:

- No experiment ever works exactly as planned. What are some possible sources of error? Concentrate your error analysis on meaningful sources of error (i.e. did you follow directions precisely? Did you use the equipment correctly?, etc.), not improbable or minute sources of error (i.e. I can't read numbers, inevitable human error, etc.).
- How would you modify the experimental procedure or your analysis process in the future? What would you do differently?

Section 3 – **P**ractical **A**pplications:

- Scientific experiments are never done in a vacuum. There is always some reason the experiment is being performed.
- Now that you have completed your investigation, what further scientific questions might arise as a follow-up to this experiment? What would be the next logical step?
- Why is this information useful? How could it be applied?
- How has your investigation expanded, supported, or questioned current scientific understanding, models, or theories?

POST-LAB QUESTIONS:
→Please answer in complete sentences in short answer form after completing the lab.
→Post-lab questions are designed to encourage critical thinking and application of background knowledge or the knowledge you gained to novel situations.

**AP Bio Lab Write-up Rubric** **Name:**

**Lab:** **Date:** **Per:**

| | ASSESSMENT CRITERIA | Exceeds Standard | Meets Standard | Approaches Standard | Below Standard |
|---|---|---|---|---|---|
| Before Lab | **Purpose of Investigation** | | **Purpose is clearly defined and articulated.** 3 | Purpose is addressed. 2 | Purpose is unclear. 1 |
| | **Hypothesis/Expected Results** | | Hypothesis is testable; "because" statement is both logical and valid 3 | Hypothesis is testable; "because" statement is illogical, invalid, or unclear 2 | Hypothesis is not testable; "because" statement illogical, invalid, or unclear 1 |
| | **Flow Chart** | Pictures and captions are neat, detailed, and specific. Flow of experiment is easily followed and well explained. 4 | Pictures and captions are neat and complete. Flow of experiment can be followed. 3 | Pictures and captions are neat, but incomplete. Flow of experiment is unclear. 2 | Pictures or captions are absent, unclear, or incomplete. Flow of experiment is unclear. 1 |
| During Lab | **Data Collection and Observations** | Data table is neat and appropriate for experiment. Units are labeled. Data is taken in pen. 4 | Data table is neat. Units are labeled. Data is taken in pencil. 3 | Data table is neat, but not quite appropriate for experiment. Units may not be clearly defined. Data is taken in pencil. 2 | Data table is incomplete, and not appropriate for experiment. Units missing. Data is taken in pencil. 1 |
| After Lab | **Conclusion – Results, Evidence Explanation** | Statement of support or refutation of hypothesis. All claims are supported by specific data. Explanations are logical and draw on scientific background. 5 4 | Statement of support or refutation of hypothesis. Claims supported by general data. Explanations are logical. 3 | Statement of support or refutation of hypothesis. Some claims supported by data. Explanations are sometimes unclear or difficult to follow. 2 | Statement of support or refutation of hypothesis. Claims rarely supported by data. Explanations unclear. 1 |
| | **Conclusion – Possible Error** | | Meaningful sources of error considered. Thoughtful analysis of how to refine experiment. 3 | Error analysis incomplete or over simplified. Feasible suggestions on how to refine experiment. 2 | Error analysis incomplete. Suggestions to refine experiment infeasible or lack thoughtfulness. 1 |
| | **Conclusion – Practical Applications** | | Complex and logical follow-up questions asked. Clear understanding of application of knowledge in larger scientific context. 3 | Simple follow-up questions asked. Some understanding of application of knowledge in broader scientific context. 2 | Irrelevant follow-up questions asked. Little understanding of application of knowledge in broader scientific context. 1 |

Pre-Lab Questions: ____/____ Post-Lab Questions: ____/____

Graph (If applicable): ____/____ Comments: TOTAL: ☐

**AP Bio Lab Write-up Rubric** **Name:**

**Lab:** **Date:** **Per:**

| | ASSESSMENT CRITERIA | Exceeds Standard | Meets Standard | Approaches Standard | Below Standard |
|---|---|---|---|---|---|
| Before Lab | **Purpose of Investigation** | | **Purpose is clearly defined and articulated.** 3 | Purpose is addressed. 2 | Purpose is unclear. 1 |
| | **Hypothesis/Expected Results** | | Hypothesis is testable; "because" statement is both logical and valid 3 | Hypothesis is testable; "because" statement is illogical, invalid, or unclear 2 | Hypothesis is not testable; "because" statement illogical, invalid, or unclear 1 |
| | **Flow Chart** | Pictures and captions are neat, detailed, and specific. Flow of experiment is easily followed and well explained. 4 | Pictures and captions are neat and complete. Flow of experiment can be followed. 3 | Pictures and captions are neat, but incomplete. Flow of experiment is unclear. 2 | Pictures or captions are absent, unclear, or incomplete. Flow of experiment is unclear. 1 |
| During Lab | **Data Collection and Observations** | Data table is neat and appropriate for experiment. Units are labeled. Data is taken in pen. 4 | Data table is neat. Units are labeled. Data is taken in pencil. 3 | Data table is neat, but not quite appropriate for experiment. Units may not be clearly defined. Data is taken in pencil. 2 | Data table is incomplete, and not appropriate for experiment. Units missing. Data is taken in pencil. 1 |
| After Lab | **Conclusion – Results, Evidence Explanation** | Statement of support or refutation of hypothesis. All claims are supported by specific data. Explanations are logical and draw on scientific background. 5 4 | Statement of support or refutation of hypothesis. Claims supported by general data. Explanations are logical. 3 | Statement of support or refutation of hypothesis. Some claims supported by data. Explanations are sometimes unclear or difficult to follow. 2 | Statement of support or refutation of hypothesis. Claims rarely supported by data. Explanations unclear. 1 |
| | **Conclusion – Possible Error** | | Meaningful sources of error considered. Thoughtful analysis of how to refine experiment. 3 | Error analysis incomplete or over simplified. Feasible suggestions on how to refine experiment. 2 | Error analysis incomplete. Suggestions to refine experiment infeasible or lack thoughtfulness. 1 |
| | **Conclusion – Practical Applications** | | Complex and logical follow-up questions asked. Clear understanding of application of knowledge in larger scientific context. 3 | Simple follow-up questions asked. Some understanding of application of knowledge in broader scientific context. 2 | Irrelevant follow-up questions asked. Little understanding of application of knowledge in broader scientific context. 1 |

Pre-Lab Questions: ____/____ Post-Lab Questions: ____/____

Graph (If applicable): ____/____ Comments: TOTAL: ☐

**AP Bio Lab Write-up Rubric** **Name:**

**Lab:** **Date:** **Per:**

| | ASSESSMENT CRITERIA | Exceeds Standard | Meets Standard | Approaches Standard | Below Standard |
|---|---|---|---|---|---|
| Before Lab | **Purpose of Investigation** | | **Purpose is clearly defined and articulated.** 3 | Purpose is addressed. 2 | Purpose is unclear. 1 |
| | **Hypothesis/Expected Results** | | Hypothesis is testable; "because" statement is both logical and valid 3 | Hypothesis is testable; "because" statement is illogical, invalid, or unclear 2 | Hypothesis is not testable; "because" statement illogical, invalid, or unclear 1 |
| | **Flow Chart** | Pictures and captions are neat, detailed, and specific. Flow of experiment is easily followed and well explained. 4 | Pictures and captions are neat and complete. Flow of experiment can be followed. 3 | Pictures and captions are neat, but incomplete. Flow of experiment is unclear. 2 | Pictures or captions are absent, unclear, or incomplete. Flow of experiment is unclear. 1 |
| During Lab | **Data Collection and Observations** | Data table is neat and appropriate for experiment. Units are labeled. Data is taken in pen. 4 | Data table is neat. Units are labeled. Data is taken in pencil. 3 | Data table is neat, but not quite appropriate for experiment. Units may not be clearly defined. Data is taken in pencil. 2 | Data table is incomplete, and not appropriate for experiment. Units missing. Data is taken in pencil. 1 |
| After Lab | **Conclusion – Results, Evidence Explanation** | Statement of support or refutation of hypothesis. All claims are supported by specific data. Explanations are logical and draw on scientific background. 5 4 | Statement of support or refutation of hypothesis. Claims supported by general data. Explanations are logical. 3 | Statement of support or refutation of hypothesis. Some claims supported by data. Explanations are sometimes unclear or difficult to follow. 2 | Statement of support or refutation of hypothesis. Claims rarely supported by data. Explanations unclear. 1 |
| | **Conclusion – Possible Error** | | Meaningful sources of error considered. Thoughtful analysis of how to refine experiment. 3 | Error analysis incomplete or over simplified. Feasible suggestions on how to refine experiment. 2 | Error analysis incomplete. Suggestions to refine experiment infeasible or lack thoughtfulness. 1 |
| | **Conclusion – Practical Applications** | | Complex and logical follow-up questions asked. Clear understanding of application of knowledge in larger scientific context. 3 | Simple follow-up questions asked. Some understanding of application of knowledge in broader scientific context. 2 | Irrelevant follow-up questions asked. Little understanding of application of knowledge in broader scientific context. 1 |

Pre-Lab Questions: ____/____ Post-Lab Questions: ____/____

Graph (If applicable): ____/____ Comments: TOTAL: ☐

**AP Bio Lab Write-up Rubric** **Name:**

**Lab:** **Date:** **Per:**

| | ASSESSMENT CRITERIA | Exceeds Standard | Meets Standard | Approaches Standard | Below Standard |
|---|---|---|---|---|---|
| Before Lab | **Purpose of Investigation** | | **Purpose is clearly defined and articulated.** 3 | Purpose is addressed. 2 | Purpose is unclear. 1 |
| | **Hypothesis/Expected Results** | | Hypothesis is testable; "because" statement is both logical and valid 3 | Hypothesis is testable; "because" statement is illogical, invalid, or unclear 2 | Hypothesis is not testable; "because" statement illogical, invalid, or unclear 1 |
| | **Flow Chart** | Pictures and captions are neat, detailed, and specific. Flow of experiment is easily followed and well explained. 4 | Pictures and captions are neat and complete. Flow of experiment can be followed. 3 | Pictures and captions are neat, but incomplete. Flow of experiment is unclear. 2 | Pictures or captions are absent, unclear, or incomplete. Flow of experiment is unclear. 1 |
| During Lab | **Data Collection and Observations** | Data table is neat and appropriate for experiment. Units are labeled. Data is taken in pen. 4 | Data table is neat. Units are labeled. Data is taken in pencil. 3 | Data table is neat, but not quite appropriate for experiment. Units may not be clearly defined. Data is taken in pencil. 2 | Data table is incomplete, and not appropriate for experiment. Units missing. Data is taken in pencil. 1 |
| After Lab | **Conclusion – Results, Evidence Explanation** | Statement of support or refutation of hypothesis. All claims are supported by specific data. Explanations are logical and draw on scientific background. 5 4 | Statement of support or refutation of hypothesis. Claims supported by general data. Explanations are logical. 3 | Statement of support or refutation of hypothesis. Some claims supported by data. Explanations are sometimes unclear or difficult to follow. 2 | Statement of support or refutation of hypothesis. Claims rarely supported by data. Explanations unclear. 1 |
| | **Conclusion – Possible Error** | | Meaningful sources of error considered. Thoughtful analysis of how to refine experiment. 3 | Error analysis incomplete or over simplified. Feasible suggestions on how to refine experiment. 2 | Error analysis incomplete. Suggestions to refine experiment infeasible or lack thoughtfulness. 1 |
| | **Conclusion – Practical Applications** | | Complex and logical follow-up questions asked. Clear understanding of application of knowledge in larger scientific context. 3 | Simple follow-up questions asked. Some understanding of application of knowledge in broader scientific context. 2 | Irrelevant follow-up questions asked. Little understanding of application of knowledge in broader scientific context. 1 |

Pre-Lab Questions: ____/____ Post-Lab Questions: ____/____

Graph (If applicable): ____/____ Comments: TOTAL: ☐