# AP BIOLOGY LAB MANUAL

## Projected Sequence of Lab Activities for 2019 – 2020:

1. Making Connections *Redux**
2. Biology Lab Skills
3. Fruit Fly Behavior*
4. Diffusion and Osmosis*
5. Enzyme Activity*
6. Organismal Respiration*
7. Chromatography Techniques
8. Photosynthesis – Light Reactions*
9. Cell Division
10. *Sordaria fimicola* Recombination Frequency
11. *Drosophila melanogaster* Genetics*
12. Polymerase Chain Reaction
13. Restriction Enzyme Simulation
14. DNA Restriction Analysis
15. Engineering a Plasmid
16. Bacterial Transformation

DNA LABS

17. Natural Selection Simulation
18. Hardy-Weinberg Simulation I
19. Hardy-Weinberg Simulation II
20. Evolution and Phylogenetics
21. Have a BLAST!

EVO LABS

22. Artificial Selection*

*requires a formal lab report

# AP BIOLOGY LAB MANUAL:

Let me be honest with you... I cannot speak for Chemistry or Physics, but the 'labs' that we did in Regents Biology were really just pen and paper exercises. The infamous "Clothespin Lab" and the "Plant Growth Project" that I ran with my freshmen classes were more of an actual lab investigations. For AP Biology, your participation in lab is an integral part of the class experience as well as your grade (40%).

Throughout this experience, you will be working with a variety of measuring devices as well as modern equipment commonly used in research labs worldwide. Be attentive to safety precautions prior to each lab activity. Your instructor will emphasize these precautions prior to each lab. Specific precautions will also be listed in the pre-lab readings.

**You are expected to read through the lab activity prior to each lab and familiarize yourself with the procedures.** All lab activities have a time constraint. To complete the activity on time requires prior planning. Preparing your Pre-Lab assignment in your lab book is mandatory for all investigations requiring a formal report. Be prepared to complete labs that go beyond the normal class period, after school if necessary. Labs will be conducted in groups, **yet understand that each student must turn in their own, unique work**. A first instance or even suspicion of plagiarism (a.k.a. **CHEATING**) will be dealt with strictly—a **0%** will be applied to the lab report score…no appeals will be taken. Second occurrence is an '**F**' for the quarter in which the offense took place. A third and final offense will be removal from the class. These are non-negotiable terms.

You will follow a general format used for research reports published in scientific journals. Although different journals require different formats, all papers have a roughly similar outline. They reflect the basic scientific method of asking a question, formulating hypotheses, conducting experiments to test hypotheses, and interpreting results. Even though not all journals require authors to divide their papers into clearly labeled sections, this practice will help you develop good habits in reporting your findings. Therefore, you are asked to label each section in your paper except for the title.

**You will have ~5 calendar days from the day of lab completion to prepare a lab report for submission. Every day late is a 10% deduction. After this time, the <u>maximum</u> score for a lab report is 50%.**

## LAB GRADING:

You will have the grading scheme used for each lab before you start. Point values will be slightly different for each section depending on the lab. Remember, the overall lab grade is worth 40% of your quarter average! See the generic version of a scoring sheet on the next page. Following that is a scoring rubric which I will use to when grading.

## PRE-LAB ASSIGNMENT:

For many of the lengthy investigations, you will first complete your pre-lab assignment in your Lab Composition Notebook. This will be due the days prior to the lab actually taking place. It will receive a score that will be factored into the overall lab grade (~10 – 20%). **If it is not turned in by time the investigation starts, you will receive a 0 for part of the overall grade.**

These are the questions that you must answer as your pre-lab (unless specific instructions are given). Answer in full sentences in your Lab Composition Notebook the following questions.

1. What is it that you are trying to figure out? That is, what is the **question** of your investigation?
2. State your **hypothesis**. Identify it as the hypothesis. (You may use "**If/Then**" statements if it helps you organize your thoughts – BUT IS NOT REQUIRED!)
3. Identify the **independent variable**. (the variable being manipulated)
4. Identify the general/overall **dependent variable**. (the one that will change)

   e.g. the amount of water used, plant growth, rate of enzymatic reaction
5. Identify ***specifically*** **what the dependent variable is that is being measured** – <u>in the correct units</u>.

   e.g. $H_2O$ consumption in mL; vertical growth of stem in mm; production of a product in mM/min; etc.)
6. What **method** and/or **time frame** is used for your measurements?

   Example: I will take readings of… …by… …every 5 minutes for 30 minutes.
7. Identify ***at least*** **two controlled factors** (other variables that are being held constant). Note that this is NOT the control group – see #8).
8. Identify what the **control group** is that will be used for comparison – if applicable. It most likely does not contain the variable being tested.
9. What is the **rate of calculation** and/or **mathematical/statistical application**?

   Example: average number of trials, slope of the curve, etc.
10. How will the **results** (data) be **presented**? (graphs, charts, etc. – you need to sketch out the visuals you will use, <u>*even though you have not collected data yet*</u>; tables need to be drawn with appropriate column/row headings; graph axes should be sketched including labels)
11. What are the **specific expected results? That is - the DATA you are expecting! WHY are you expecting it?** (THIS IS NOT JUST RESTATING YOUR HYPOTHESIS – but what you expect the data to be from the investigation… This will be your best educated guess based on the readings in the labs, and any other research you decide to do *on your own*. Yes, you should read the introductions to the labs.)

# Guidelines for Writing a Scientific Paper

Writing an effective scientific paper is not easy. A good rule of thumb is to write as if your paper will be read by a person who knows about the field in general but does not already know what you did. Before you write a scientific paper read some scientific papers that have been written in the format of the paper you plan to use. In addition to the science, pay attention to the writing style and format. (DOUBLE SPACED – PLEASE!!!)

## COVER (TITLE) PAGE:

On the cover page, list the title of your specific investigation (not just the lab name from the manual!). A general rule of thumb (but not always applicable is somewhat like the following example: **"The Effect of <your independent variable> on your <dependent variable>"**. Beneath this is traditionally the abstract (more on this below). Names of group members, class period, instructor, and date submitted should be at the bottom right of this page.

## ABSTRACT:

An abstract is a succinct (one paragraph) summary of the entire paper. The abstract should briefly describe the question posed in the paper, the abbreviated methods used to answer this question, the results obtained, and the conclusions. It should be possible to determine the major points of a paper by reading the abstract. Although it is located at the beginning of the paper, it is *easiest* to write the abstract after the paper is completed.

## INTRODUCTION:

This section of your lab report provides the conceptual basis and/or theoretical background of your experiment. Design this section of your lab report using three (3) 'sections':

1. **Identify and in detail**, **explain** the question investigated – along with the theory/principle/concept illustrated*. Use in-text citations (properly formatted – see citation section) when quoting the textbook or various other resources.
2. **Describe** the basic components of the experiment. This subsection should **just** be a short paragraph that specifically states the independent, dependent, and 'controlled' variables.
3. **Clearly identify your hypothesis and explain how this design will test it—that is, what you expect will happen and what you expect your specific data will be from the investigation.**

*This introduction section will take some research. Do not try to do this off the top of your head!*

## METHODOLOGY

The Methodology section should succinctly describe what was actually done. It should include description of the techniques used so someone could figure out what experiments were actually done. **Do not just copy the steps from the manual!** This should be written in paragraph form, third person, past-tense. Any equations used for calculations (rates, amount of product determination, etc.) must be stated here ***without*** actual computations.

## RESULTS – OPENING STATEMENT

Begin this section with an opening sentence that tells the reader the generalized results were. **Write the opening sentence in bold font for emphasis**. Then, follow this with a paragraph that indicates what the results were – use the data! Any results that include multiple data points that are critical for the reader to evaluate the experiment should be shown in tables or figures (see next section). However, the results should be summarized in accompanying text. When referring to a particular table or figure, they should be capitalized (e.g., Table 1, Figure 6, etc.). The text of the Results section should be succinct but should provide the reader with a summary of the results of each table or figure.

Not all results deserve a separate table or figure. As a rule of thumb, if there are only a few numerical results or a simple conclusion, describe the results in the text instead of in a table or figure.

Your paper should focus on what worked, not things that did not work (unless they didn't work for reasons that are interesting and provide biological insights).

## RESULTS – TABLES AND FIGURES

All tables and figures should be put into a contextual framework in the corresponding text. (A table of bacterial strains used should be mentioned in the Methodology section, a table of data collected should be summarized in the Results section, a figure showing a biosynthetic pathway to further explain a concept should be described in the Introduction or Discussion section, etc.) Tables and figures should present information in a format that is easily evaluated by the reader. **A good rule of thumb is that it should be possible to figure out the meaning of a Table or Figure without referring to the text**. Tables and figures should typically summarize results, not present large amounts of raw data. When possible, the results should provide some way of evaluating the reproducibility or statistical significance of any numbers presented.

- Tables should be sequentially numbered. Each table should have a caption (shown *above* the table) that describes the point of the table. For example, "Table 1: Bacterial strains and plasmids used in this study." If necessary to interpret the table, specific descriptions about what a result represents or how the results were obtained can be described in a legend below the table.
- Figures should be sequentially numbered. Each figure should have a caption (shown *below* the table) that describes the point of the table. For example, "Figure 1. Isolation of *MudJ* insertion mutants." If necessary to interpret the figure, specific descriptions about what a result represents or how the results were obtained can be described immediately following the title.

Tables and figures should be integrated into the paper. Make sure that there is not a page break in the middle of a table or figure. Do not wrap text around the outside of tables and figures – if the results are important enough to show as a table or figure they should stand out on the page, not be buried in text. Formatting counts! Make this section easy to read!

## DISCUSSION - CONCLUSIONS

In this section of your lab report, **you will give your interpretations of the data**. You must open with a statement that either shows that the data supported or refuted your hypothesis. **Either way, explain the significance of your data**. Do not simply restate the results — explain your conclusions and interpretations of the Results section. How did your results compare with the expected results? What further questions/predictions can be gleaned from the results? In this section, "dazzle us" with your knowledge of the concept and why the results were what they were. This is the goal of each experiment — to see if your hypothesis stands up to testing and to possibly prompt new questions!

## ERROR ANALYSIS – ERROR ANALYSIS

Finally, you will have to provide **one and only one** actual (or possible) source of error that did (or might have) influence the results. This is more than just stating "We could have measured the sample wrong". To receive full credit for this, you must do the following three things:

1. List actual (or possible) source of errors that did (or would have) altered the results.
2. Describe the effect on the results caused (or would have) by each possible error.
3. Explain how you could correct the error.

## CITATIONS/REFERENCES:

Whenever you are using information from other sources, you need to properly cite your work – we will use APA format. Also, when using these external sources, it is not a cut and paste and be done with it method. You must write out the findings in your own words and then properly cite it. If this does not occur, it is called plagiarism—and you will lose credit for the **entire** lab—or worse! Oh, and **USING WIKIPEDIA IS NOT A VALID SOURCE OF INFORMATION!**

When using online documents here is the minimal citation required (APA format) below. Any sources will be listed at the end of the paper in a separate section labeled "Citations".

Author - person or organization. (Year published or updated). *Title page italicized.* Retrieved from URL

**Example**:

Fernández-Moreno, M. A. (2007). *Drosophila melanogaster as a model system to study mitochondrial biology*. Retrieved from https://link.springer.com/protocol/10.1007%2F978-1-59745-365-3_3

When you reference the source in the text body, you should list the author (either person or organization), and year published IMMEDIATELY after the material. **DO NOT LIST THE WEBSITE OR ENTIRE CITATION IN THE MAIN TEXT BODY!**

**Example**:

…blah blah blah blah blah blah **(Fernandez-Moreno, 2007)** blah blah blah. Blah blah blah blah blah blah blah **(DeMarco, 1994)** blah blah blah blah…

## SOME STANDARD ABBREVIATIONS:

| Unit | Abbreviation | Definition |
|---|---|---|
| Time | sec | seconds |
| | min | minutes |
| | hr | hours |
| Mass | g | grams |
| | mg | milligrams ($10^{-3}$ g) |
| | μg | micrograms ($10^{-6}$ g) |
| Volume | l | liter |
| | ml | milliliter ($10^{-3}$ l) |
| | μl | microliter ($10^{-6}$ l) |
| Nucleotide length | bp | base pairs |
| | Kb | kilobase pairs ($10^{3}$ bp) |
| | Mb | megabase pairs ($10^{6}$ bp) |
| Common molecular biology terms | A, T, G, C, U | adenine, thymine, guanine, cytosine, uracil |
| | DNA | deoxyribonucleic acid |
| | RNA | ribonucleic acid |
| | NAD | nicotinamine adenine dinucleotide |
| | EDTA | ethylenediamine tetraacetic acid |
| | TRIS | tris(hydroxyamino)methane |
| | UV | ultraviolet light |
| Symbols for chemical elements | C, N, P, Na, etc | carbon, nitrogen, phosphorus, sodium, etc |
| Three- or one-letter abbreviations for amino acids | e.g. Ala (A) | alanine |
| | Arg (R) | arginine |
| | Asn (N) | asparagine |
| | Asp (P) | aspartic acid |
| | Cys (C) | cysteine |
| | Gln (Q) | glutamine |
| | Glu (E) | glutamic acid |
| | Gly (G) | glycine |
| | His (H) | histidine |
| | Ile (I) | isoleucine |
| | Leu (L) | leucine |
| | Lys (K) | lysine |
| | Met (M) | methionine |
| | Phe (F) | phenylalanine |
| | Pro (P) | proline |
| | Ser (S) | serine |
| | Thr (T) | threonine |
| | Trp (W) | tryptophan |
| | Tyr (Y) | tyrosine |
| | Val (V) | valine |