**The IA Experience in 6 Parts (Biology)**

**The Internal Assessment--Part 1—Select and Research Your Topic. Due: Friday 8 December 2017—share on Google (50pts)**

**Task 1—**Set up a TURNITIN account and create an IA folder in Hapara For each document you submit, it must include the Title of your IA and the version.

**Task 2**--Describe 3 topics that you are considering doing an IA on. They must be at a level appropriate for an IB Biology senior—not something a middle school student could do. You should include what the IV and DV for each one would be and how you expect to measure the DV, as shown below **(50 points formal grade)**

**Research Question:** (what is the question you want to investigate? It should be clear what your IV and DV will be in the question. For example: “Does the daily average temperature affect the number of Fall Webworms, *Hyphantria cunea* hatching?” See?--The IV is daily average temperature and the DV is the number of webworms hatching each day.

**Independent variable**—What factor will you be testing? What levels of the IV will be used? For example in the example above, the IV is temperature and there would be at least 5 levels in a temperature range appropriate for that organism.)

**Dependent Variable**—(What will you be measuring? How will you measure it? For example: “The number of stomata in the field of view at 400x will be counted for 5 leaves from each plant…Density of stomata per mm2 will be calculated”)

**Possible types of tasks include:**

* A hands-on laboratory investigation
* Extracting data from a database and analyzing it graphically (database must be approved)
* Producing a hybrid of spreadsheet/database work with a traditional hands-on investigation
* Using a simulation provided it is interactive and open-ended (must be approved)

**You cannot do any of the following:**

* **Experiments that include or produce unknown bacteria or molds** ( You can do some experiments with purchased bacteria that are safe for school use.)
* **Experiments that involve ANY harm to animals of any kind.**
* **Experiments that involve any kind of physical stress on the human body.**

**Deciding on a Research Question**The biggest obstacle to doing well in the individual investigation for most students is not putting enough thought and effort into coming up with a good question. Key considerations when thinking up a research question should be:

* The question interests you and is related to BIOLOGY.
* The question maybe based on a well-used method/protocol, but it is unique or changed in some way that makes it very much your own work
* The question can be used to form hypotheses and can be answered by gathering and analyzing data
* The question being asked should have some value—should lead to a better understanding of the subject matter. (For example—testing the effects of different liquids on osmosis in potatoes—what practical value does this have? But if you were to do a comparison between different specific solutes on osmosis, that includes their molarity and a discussion of their chemical structure in relation to how they affect osmosis in potatoes, then we might learn something.)

Stuck for ideas? Need help developing a method?  
All good investigations will be based on scientific theory and prior investigations, but they will develop what has been done previously, not simply repeat it. Two things you must bear in mind when using theory or methods developed by others should be:

1. If you use a webpage or document you **must** cite it.
2. It is required that if your investigation is based on a published one that you put sufficient effort into developing and making it your own and differentiating it from the source. If you don't the marks you can gain under the exploration criteria will be extremely limited. Cite the source for the inspiration.
3. The websites below are known to contain information ideas for research questions. Not ALL are high level—I still have to approve your idea. And remember—these are for inspiration and ideas for how to measure things. You should not just pick one and do it as is:

* [Science And Plants for Schools](http://saps.org.uk/" \t "_blank) (<http://saps.org.uk/> ) has lots of botanical investigations and ideas
* [Practical Biology](http://www.nuffieldfoundation.org/practical-biology" \t "_blank) ( <http://www.nuffieldfoundation.org/practical-biology> ) brings together lots of different biology practicals for all ages of student
* [Senior Biology](http://seniorbiology.com/eei.html" \t "_blank) ( <http://seniorbiology.com/eei.html> ) has a list of investigation ideas for extended essays that are also suitable for individual investigations
* [Vernier dataloggers](http://www.vernier.com/ib-correlations/ib-biology/" \t "_blank) ( <http://www.vernier.com/ib-correlations/ib-biology/?_sm_au_=iVVPM05q0WMVRWpj> ) can be used in individual investigations and Vernier publishes ideas and details of how they can be used. We have PASCO datalogging equipment and many of these same sensors. See me for specifics.
* <http://i-biology.net/options/option-e-neurobiology-and-behaviour/investigation-ideas/>
* <http://moodle.nks.kent.sch.uk/mod/page/view.php?id=5465> --just looking at titles can give you ideas.

4. Think about labs you’ve done in the past which you could do an extension on—meaning you take it to a different level or in a different direction. Explore a new method for measuring and collecting data.

5. Effects of inhibitors on enzymes/Use different enzymes/Use different methods for measuring an enzymatic reaction; etc.

6. Antimicrobial properties of various plants using a safe version of *E. coli* bacteria

7. Behavior labs with small invertebrates.

8. Databases can be used to answer research questions if the data is being collected and used from the database to answer a unique question. What qualifies as a database? Generally it is a site that has been collecting basic information over many years and possibly over many locations. It is NOT a data table from someone’s published paper. Some examples of data bases include the World Health Organization for data on global health issues, the Audubon Christmas Bird Count for historic and geographical data on bird populations, and various databases on climate and weather conditions. Some databases require you to ask for permission to access the data. DO NOT submit a research question that involves the use of a database if you have not accessed one in order to determine if it will have what you need to answer the question. Any database used must be approved.

**The Internal Assessment--Part 2—Due: Friday 12 January—share on Google and TURNITIN (100pts)**

*You should now have finalized your topic and should have read over my comments on Part 1. BEFORE starting to experiment, you are to complete the following. (This is directly from the IA Lab Report document in* ***Schoology****.) This task should be written in the following format—with the bold headings as shown. The good news is that once this is done, half of your report is written!*

**Research Question:** WHAT are you trying to answer and HOW are you going to go about finding the answer? It should be clear what your IV and DV will be in the question. For example: “Does the daily average temperature affect the number of Fall Webworms, *Hyphantria cunea*, hatching?” See?--The IV is daily average temperature and the DV is the number of webworms hatching each day. Also note that the scientific name is included, written properly in italics. Write about WHY it is important to know the answer to this question and why YOU want to know the answer (Personal Engagement).

**Background Information:** If you have not done any research before starting your experiment, how can you know what kinds of things might affect it or what the best way to measure something is? It may include background information on several things that are related to your IA—like the organism you are using, techniques being used, background on biological processes or the database being used, etc. BUT don’t just write a lot general stuff that has nothing to do with your research question—make it relevant.

CITE YOUR SOURCES! Use internal citations with a bibliography at the end. I would expect AT LEAST 1 full page of background information and some of you will need to do a lot more for your topic. No Paper will be turned in to IB without proper citations—that would be plagiarism. Same goes for any section of this report—if you got inspiration for your procedure from another source—cite it!

**Experimental Design:** List and describe the following variables:

**Independent variable**—How many levels of your independent variable and why these levels were selected. Don’t pick randomly—have a reason!! You should have a minimum of 5 levels and more is better. For example—5 different temps that you are testing an enzyme with, and those temps are not so cold or so hot that you should know that nothing is going to happen.

**Dependent variable**—What will you be measuring? How will you measure it? For example: “The number of stomata in the field of view at 400x will be counted for 5 leaves from each plant…Density of stomata per mm2 will be calculated” Some of you may have more than one DV. And everyone should include qualitative data that you are observing as you do the experiment—especially things that might affect the reliability of the data. (Database people—instead of qualitative data, record anything about the database and how its data was collected that might affect the accuracy or reliability of the data found in it. That can go in the procedure as part of describing the database you are using.)

**Constants**—NOT control group! Create a table like the one below and list each variable that could affect the results, how it could affect the results and how you are going to control for that possible effect. You should be able to think of at least 3. Don’t forget—it’s not just about the test subjects but also about control of HOW the data is collected

|  |  |  |
| --- | --- | --- |
| **Constants:** | **Possible Effect:** ( if it’s not controlled) | **Control Method:** |
| *--use as many rows as you need to cover all the controlled variables. You should have at least 5.* |  |  |

**Control Group—**What will be the control group that you will compare the experimental groups to? There may not be one if you are comparing 2 groups—like males vs. females.

**Procedure**—This is not stream of consciousness! PLAN and THINK about how you would tell someone how to do your procedure so that it is CLEAR and CONCISE with no rambling sentences and no superfluous stuff like “take out the microscope”—DUH. Write out a rough draft and then rewrite so it makes sense. Have someone read it and ask them if there is enough information in it that they could do your experiment with just these directions.

Be sure to include the correct names of equipment used, and sizes of beakers, etc.

It should include more info on how the levels of the independent variable were selected, how the dependent variable was measured, and how many repeated measurements were taken. Not good—1 leaf from 3 different types of plants. This is not sufficient data and would not allow for averaging.

You should have at least a 5 x 5 plan—5 levels with 5 measurements each or more.

If there are only 2 levels of the IV, because that’s all there is, then make more measurements.

Describe more completely the controlled variables, why they might have an effect and how you controlled them—written as part of the procedure of when and how you controlled these variables.

Include a plan and a place for collecting qualitative data—data that describes, is not numerical or measurable. These are the kinds of things that might be observed or happen during the course of the experiment that may have an effect on the results.

Include safety or environmental concerns appropriate to your experiment. If using a database, you still have to at least make a statement about there not being any safety issues. If using animals you need to read IB’s policy on animal testing and explain how you were following those guidelines. You can do nothing that will in any way harm any animal. If using human test subjects, you must have each person complete a release form. For either animals or human testing, you must have my approval before beginning. I will not approve any experiment that harms or has the potential to harm any animal or human.

*You probably will have to tweak these procedures a little for your final report as you figure out how much of things to use or how long something actually takes. But these changes should be minor. Come up with a good procedure NOW.* Do a test to see if it works.

**Results**—Basically your raw data. Prepare a blank data table BEFORE YOU START COLLECTING DATA that will allow you to record all raw data—quantitative and qualitative--according to your experimental design. It should have a clear descriptive title, and clearly labeled columns and rows.

ALL DATA TABLES SHOULD HAVE A DESCRIPTIVE TITLE (NOT “DATA TABLE”) THAT CLEARLY LETS SOMEONE KNOW WHAT THE NUMBERS ARE ABOUT.

Raw data must be included in the final report. I want to see a data table now that goes with your procedure.

If you use a database, include a section/screenshot of it in your paper to show what it looks like, along with a citation and link.

A column or row for averaging and other statistics may be included with the raw data or they may be shown on a separate data table under DATA ANALYSIS, or BOTH—do what makes it look most clear.

Include units of measurement. No Naked Numbers!

**Bibliography—**MLA, APA, —I don’t care, but use proper format for which ever style you use.

**Internal Assessment –Part 3—Due Friday 26 January 2018—(50pts)**

Perform the experiment—

Do not expect your procedure to go perfectly the first time! Its not you—even the best scientists have to work through issues with their procedure they did not foresee. So give yourself time to TEST the procedure with a trial run. Figure out the right measurements, the right amount of time to let something run for, etc.

You may use the materials, grow lights, computers, and space here in the classroom and in the back prep room for your experiment. Work with bacteria should be done at school, for safety reasons. IF you choose to do the experiment at home, you must provide me with photos of your progress, with you in the pictures. (Database IAs are excluded from this.)

If you are growing plants or anything else that is going to take time, you need to get started ASAP!

If you are using people, you must get permission forms signed by each test subject. Form is in **Schoology**.

**What to turn in:**

* Raw Data—data tables with descriptive titles, units, neatly printed and organized
* Data processing plan
  + Description of what data processing will be done—averaging, percentages, percent change, standard deviation, type of error bars, t-test, chi-square test, correlation test, or other statistics. Depends on what your data is about. What are you planning to graph? What kind of graph? (Your IB Workbook and my website (mrgscience.com) has some good information on statistics.)
  + Justifications for the choices—why do you expect the data processing to reveal?
  + See Part 4 below for what things I will be looking for.

**Internal Assessment—Part 4: Processed Data and First Draft—Due Friday 2 February 2018 - Share on Google and TURNITIN (100pts)**

* Draft of **ALL** aspects of the IA to date (all but the full conclusion and evaluation)
  + A working descriptive **title**
  + **Research question**
  + **Background research**
  + **Experimental design**
  + **Procedure**—with any changes made after doing the experiment!

**All of the above will be scored for the final time. I will give feedback on the items below for you to make changes:**

* + **Results**
    - Raw data with some processed data—averages, standard deviation, etc.
    - “Raw”data is included in the final report—but clean it up! If it makes more sense to show it in a different order than the way you took the data, then do that in your final report.
    - Include uncertainty in the measurements. (Depends on the method/instrument being used)
    - BE consistent with decimal points!
    - Include units of measurement. No Naked Numbers!
    - When doing statistics, show the formula and a sample calculation. If the statistic was obtained by using a program on a calculator, spreadsheet, or online statistical calculator, cite it.
* **Data Analysis**—this includes your fully processed data.
* Calculate standard deviation for means if you did not do so in the Results section.
* Graph the data using the appropriate type of graph and include error bars.
* Add a footnote to your graph saying what the error bars represent—range, standard deviation. See the guide on Edmodo for making graphs with error bars using Excel. If you do not have enough data to use standard deviation for error bars, use range bars.
* Use an appropriate statistical test to assess your data. Use a t-test for an experiment with 2 groups, or a chi-square test if there are more than 2 groups to see if your groups are significantly different. Use a correlation test if you trying to prove a relationship between two separate things.
  + <http://www.excel-easy.com/examples/t-test.html> --how to do a t-test using excel.
  + <https://www.youtube.com/watch?v=BlS11D2VL_U> –video on doing a t-test using excel.
  + <http://www.statisticshowto.com/calculate-chi-square-p-value-excel/> --video tutorial on doing chi-square test using excel.
  + <https://cyfar.org/types-statistical-tests> - types of statistical tests
* Either of these tests will let you know if the differences you see in your data are significantly different or are due to chance.
* Look at the qualitative data—you remembered to collect some didn’t you? Does any of it lend any clarity about the results, or affect the results?
* Outline of **Conclusion--**Noting key points of connection to data. Where do you think the data is leading you? Refer to particular parts of the processed data that reveal something to you about the answer to your research question.

**Internal Assessment—Part 5: Complete first draft due—Due Friday 9 February 2018 Share on Google and TURNITIN (150 formal points)**

* Complete draft deadline—**in addition** to Part 4 work, complete conclusion and evaluation are due
* **Conclusion**—Be **ClEvR—**
  + State you **CL**aim about the answer to your research question.
  + Provide the **Ev**idence from your data and calculations that support your claim. Be   
     specific! Do not say something like “the graph shows that treatment 2 was the   
     best”. What graph? How does it show that? Do not make the reader have to go   
     back and analyze the data for you. That is your job.
  + Infer a scientific **R**eason for why this might be true based on your results and your   
     understanding from your background research, or--even better!--published data if   
     you can find any—with citations.
* **Evaluation**—Evaluate the procedure—not human error, unless the procedure is such that it   
   leads to human error. See the IA checklist on **Schoology** for specific parts of the procedure that   
   should be discussed and give suggestions for improving the procedure for every weakness you   
   found in the procedure. If your experiment results in new questions about your subject that   
   arise, discuss those.
* ONLY chance for teacher feedback on full document

**Internal Assessment—Part6: Final Paper Deadline**—**Due: Friday 16 February 2018 (150 point formal grade)**