3 "seeds" : Internal Assessment's individual investigation Preparation recommended Assignment

Dear IB Bio II students for 2022-2023
The internal assessment is traditionally 20% of a student's IB Biology score. For 2019-2020 IB made it essentially all of the IB score. So, even though IB international is reviewing how to pragmatically approach the year 2020-2021 given the pandemic's interruption of education, the IA's individual investigation will undoubtably remain be essential for the 2020-2021 IB assessments.

My philosophy is work smarter, not harder. A few hours (3-6 hours) of summer work will save you significant stress next year as it will provide you time to let ideas percolate in the back of your mind over days or weeks, this can lead to greater efficiency and inspiration. Below is summer recommended assignment that helps you productively brainstorm up ideas for your Internal Assessment project. If you do not have electronic access, then work with the resources you have and neatly hand write your 3"seeds" assignment. If you have electronic access please join Edmodo, and do your work electronically, as it will be easier to revise and revisit later.

Email me if you have questions or issues with Edmodo (yes you can use Edmodo messaging, but I see email notifications more quickly).

Enjoy your summer,
Ms. McKay
emckay@tusd.net

IA Theme for School year 2022-2023 **The human connection: Agriculture, the environment, or health** (health will have strict limitations according to human subjects/ animal subjects... probably best for computer modeling or databased labs).

-**easily relates to SL/HL standards on** ... SL/option standards on ecology, HL standards on plants, option standards in biotech and ag, biotech and medicine, microbiology, and bioinformatics or the SL/HL Photosynthesis.

- **Standards with linked resources:** http://ib.bioninja.com.au/
- **Standards with guidance (pdf p.35-end):** https://www.gresham.k12.or.us/cms/lib/OR02216641/Centricity/Domain/1154/Biology%20Guide.pdf
- **How does the individual investigation fit in with IB international curriculum guide?** https://www.ibo.org/globalassets/publications/recognition/biologyhl2016englishw.pdf

Pre Reflection:

Think about what you know about ______. Think about why ______ are important in biology. Think about how ______ fits into the macro/ micro/ or both aspects of biology.

Need a starting reference?

- Skim the DOCUMENT: OLD_Biology_for_the_IB_Diploma from the old standards see link http://tfssbio.pbworks.com/w/file/fetch/54980708/Biology_for_the_IB_Diploma.pdf
- Or current resources: see Edmodo IB Bio II (2020-2021) Folders → readings

Review the Appendix: Skills in the New IB Biology Syllabus 2016 for a "seed" of an idea. Note not all skills are applicable to the theme.

REFER to DOCUMENT: Practical work and internal assessment IA_Guide_2016 is a description of IB Internal assessment and its rubric.

Some of the possible tasks include:

- **Simulation/ Modeling**
  - using a simulation that is interactive and open-ended. Ex: http://virtualbiologylab.org/population-genetics/
  - Using computer science skills to build a virtual lab/ simulation

- **extracting data from a database and analyzing it graphically**
  - Ex: medical data: https://www.nlm.nih.gov/hsrinfo/datasites.html , https://www.cdc.gov/nchs/data_access/ftp_data.htm
  - Ex: Ecological Data Wiki http://ecologicaldata.org/ especially https://ecologicaldata.org/find-data
  - If you find interesting raw data from a researcher...do not bug them to ask them mindless and/or time wasting questions...they are VERY BUSY!
  - Go to www.water.ca.gov and https://cdec.water.ca.gov/ You can search for interesting data on the Delta, the Skinner fish facility's that samples fish coming through the California Aqueduct, etc. https://www.dfg.ca.gov/delta/Data/Salvage/SalvageOverview.asp

- **using a spreadsheet for analysis and modelling**
- producing a hybrid of spreadsheet/database work with a traditional hands-on investigation (FYI: iNaturalist http://www.inaturalist.org/ is a resource that might be useful. It is free to sign up. And check out like https://www.inaturalist.org/places/tdwg-2016-annual-meeting-bioblitz)

- **Independent field work.**
  - **IA_ecology_methods_BZ.pdf** attachment provides easy background from Biozone 216-221 gives simple examples of how to do ecology experiment methodologies that could be applied any where from your backyard to, to a state park like Caswell state park in Ripon.
  - w/ parental permission, permission of land owner/ proper use of public/state park, and a buddy ...it is rarely a good idea to go into the field on your own ...well unless your using something like your own backyard for research...and yes some discoveries are still being made in our "own backyards" http://voices.nationalgeographic.com/2014/12/17/the-next-new-species-could-be-in-your-backyard/)

- **a hands-on laboratory investigation**

- **Control group, Independent variable with at least 3 manipulations.**
- **How many trials of each manipulation? It depends**
    - **Labs where genetic variation isn't an issue, minimum of where consistency**

Assignment:

1. **Come up with 3 "seeds"** of ideas for an internal assessment (they could be broadly focused to very focused for this assignment).
    a. Example if the Theme was YEAST and we didn't have to worry about bioethics, safety or laws
        i. Using baker's yeast to brew beer
        ii. Determining the growth curve of wild environmental yeast that from San Francisco that makes yummy sour dough French bread.
        iii. Thrush infections: Is there a difference between breast fed babies and bottle fed?
2. Research EACH idea (3-4 sources suggestions beyond **bioninja!** And **Bozeman biology** –google "Biology for the IB Diploma" there is an old Cambridge IB book pdf on line that a nice level of depth)
3. **For EACH idea** do a mini write up (150-300 words using APA intext citations and don't forget the works cited)
    a. **Background Information**
    - Paraphrased information (material that you put into your own words) should be stated then followed by (Smith, 2008).
    - Direct quotations should be placed inside quotation marks and then followed by (Smith, 2008).

    b. **Rational For The Study (IAMF- Personal Engagement):**
    - You must state WHY you are interested or curious about this problem and state its personal significance to you.

    c. **Possible Research Question:** Write a possible research question that could lead to a REALISTIC internal assessment lab. Use the format, "What is the effect of X on Y, where X is the independent or manipulated variable and Y is the dependent or responding variable "as measured by." But, if the experiment is more "discovery science style, then feel free to modify the research question format as necessary.

BELOW is a TEMPLATE DOCUMENT
AT the END is the **Appendix: Skills in the New IB Biology Syllabus 2016 (the first year of testing on these standards)**

Internal Assessment Preparation Assignment Name:

Theme for School year 20192020 **The human connection: Agriculture, the environment, or health**

450-900 words, 3-12 sources

- ☐ Idea 1 MUST be a traditional science: wet lab idea
- ☐ Idea 2 MUST be something else, Modern Science: databased, virtual/computer model, field work…
- ☐ Idea 3- your choice: ecology (old school field work that requires decent shoes or modern databased/modeling)

"Seed" of an idea 1 (150-300 words including **3-4 sources** using APA in text citations)

TRADITIONAL Science: WET LAB EXPERIMENT IDEA

A. **Background Information**

B. **Rational For The Study (IAMF- Personal Engagement):**

C. **Possible Research Question:**

"Seed" of an idea 2 (150-300 words including **3-4 sources** APA in text citations)

Modern Science: databased, virtual/computer model,

A. **Background Information**

B. **Rational For The Study (IAMF- Personal Engagement):**

C. **Possible Research Question:**

"Seed" of an idea 3 (150-300 words including **3-4 sources** APA in text citations)

Ecology: field work, databased, virtual/ computer model

A. **Background Information**

B. **Rational For The Study (IAMF- Personal Engagement):**

C. **Possible Research Question:**

Works Cited (total of **3-12 sources** using APA format)

Appendix-Skills in the New IB Biology Syllabus 2016…might give you jumping off point ideas

Topic 1

- Use of a light microscope to investigate the structure and ultra structure of cells and tissues, with drawing of cells and calculation of the magnification of drawings and the actual size of structures shown in drawings or micrographs. (Practical)
- Estimation of osmolarity in tissues by bathing samples in hypotonic and hypertonic solutions. (Practical 2)
- Identification of phases of mitosis in cells viewed with a microscope or in a micrograph.
- Determination of a mitotic index from a micrograph.

Topic 2

- Use of molecular visualization software to compare cellulose, starch and glycogen. Design of experiments to test the effect of temperature, pH and substrate
- concentration on the activity of enzymes
- Experimental investigation of a factor affecting enzyme activity (Practical3). Analysis of results from experiments involving measurement of respiration rates in
- germinating seeds or invertebrates using a respirometer.
- Design of experiments to investigate the effect of limiting factors on photosynthesis. Separation of photosynthetic pigments by chromatograph. (Practical4)

Topic 3

- Use of a database to determine differences in the base sequence of a gene in two species.
- Use of karyograms to deduce sex and diagnose Down syndrome in humans
- Use of a database to identify the locus of a human gene and its polypeptide product
- Design of an experiment to assess one factor affecting the rooting of stem-cuttings.

Topic 4
Setting up sealed mesocosms to try to establish sustainability (Practical 5). Testing for association between two species using the chi squared test with data
obtained by quadrat sampling.

Topic 6

- Monitoring of ventilation in humans at rest and after mild and vigorous exercise.

(6th practical.) Topic 7

- Utilization of molecular visualization software to analyse the association between protein and DNA within a nucleosome.
- The use of molecular visualization software to analyse the structure of eukaryotic ribosomes and a tRNA molecule.
- Calculating and plotting rates of reaction from raw experimental results.

Topic 9

- Measurement of transpiration rates using potometers. (Practical 7)
- Design of an experiment to test hypotheses about the effect of temperature or humidity on transpiration rates.
- Design of experiments to test hypotheses about factors affecting germination.

Option B

- Gram staining of Gram positive and Gram negative bacteria.
- Experiments showing zone of inhibition of bacterial growth by bacteriocides in sterile bacterial cultures.
- Production of biogas in a small scale fermenter.
- Explore the chromosome 21in databases (for example in Ensembl). Use of software to align two proteins.
- Use of software to construct simple cladograms and phylograms of related organisms using DNA sequences

Option C

- Use of a transect to correlate the distribution of plant or animal species with an abiotic variable.
- Investigation into the effect of an environmental disturbance on an ecosystem. Analysis of the biodiversity of two local communities using the Simpson reciprocal index.
- Modelling the growth curve using a simple organism such as yeast or species of Lemna.
- Assess the nutrient content of a soil sample.

Option D

- Determination of the energy content of food by combustion.
- Use of databases of nutritional contents of foods and software to calculate intakes of essential nutrients from a daily diet.
- Identification of pneumocytes, capillary endothelium cells and blood cells in light micrographs and electron micrographs of lung tissue
- Measurement and interpretation of the heart rate under different conditions. Interpretation of systolic and diastolic blood pressure measurements. Mapping of the cardiac cycle to a normal electrocardiogram (ECG) trace.

- The highest level descriptors do not imply faultless performance but should be achievable by a student. Teachers should not hesitate to use the extremes if they are appropriate descriptions of the work being assessed.
- A student who attains a high achievement level in relation to one criterion will not necessarily attain high achievement levels in relation to the other criteria. Similarly, a student who attains a low achievement level for one criterion will not necessarily attain low achievement levels for the other criteria. Teachers should not assume that the overall assessment of the students will produce any particular distribution of marks.
- It is recommended that the assessment criteria be made available to students.

Practical work and internal assessment

General introduction

The internal assessment requirements are the same for biology, chemistry and physics. The internal assessment, worth 20% of the final assessment, consists of one scientific investigation. The individual investigation should cover a topic that is commensurate with the level of the course of study.

Student work is internally assessed by the teacher and externally moderated by the IB. The performance in internal assessment at both SL and HL is marked against common assessment criteria, with a total mark out of 24.

Note: Any investigation that is to be used to assess students should be specifically designed to match the relevant assessment criteria.

The internal assessment task will be one scientific investigation taking about 10 hours and the write-up should be about 6 to 12 pages long. Investigations exceeding this length will be penalized in the communication criterion as lacking in conciseness.

The practical investigation, with generic criteria, will allow a wide range of practical activities satisfying the varying needs of biology, chemistry and physics. The investigation addresses many of the learner profile attributes well. See section on "Approaches to teaching and learning" for further links.

The task produced should be complex and commensurate with the level of the course. It should require a purposeful research question and the scientific rationale for it. The marked exemplar material in the teacher support material will demonstrate that the assessment will be rigorous and of the same standard as the assessment in the previous courses.

Some of the possible tasks include:

- a hands-on laboratory investigation
- using a spreadsheet for analysis and modelling
- extracting data from a database and analysing it graphically
- producing a hybrid of spreadsheet/database work with a traditional hands-on investigation
- using a simulation provided it is interactive and open-ended.

Some tasks may consist of relevant and appropriate qualitative work combined with quantitative work.

The tasks include the traditional hands-on practical investigations as in the previous course. The depth of treatment required for hands-on practical investigations is unchanged from the previous internal assessment and will be shown in detail in the teacher support materials. In addition, detailed assessment of specific aspects of hands-on practical work will be assessed in the written papers as detailed in the relevant topic(s) in the "Syllabus content" section of the guide.

The task will have the same assessment criteria for SL and HL. The five assessment criteria are personal engagement, exploration, analysis, evaluation and communication.

Internal assessment details

Internal assessment component

Duration: 10 hours
Weighting: 20%

- Individual investigation.
- This investigation covers assessment objectives 1, 2, 3 and 4.

Internal assessment criteria

The new assessment model uses five criteria to assess the final report of the individual investigation with the following raw marks and weightings assigned:

Personal engagement	Exploration	Analysis	Evaluation	Communication	Total
2 (8%)	6 (25%)	6 (25%)	6 (25%)	4 (17%)	24 (100%)

Levels of performance are described using multiple indicators per level. In many cases the indicators occur together in a specific level, but not always. Also, not all indicators are always present. This means that a candidate can demonstrate performances that fit into different levels. To accommodate this, the IB assessment models use markbands and advise examiners and teachers to use a **best-fit approach** in deciding the appropriate mark for a particular criterion.

Teachers should read the guidance on using markbands shown above in the section called "Using assessment criteria for internal assessment" before starting to mark. It is also essential to be fully acquainted with the marking of the exemplars in the teacher support material. The precise meaning of the command terms used in the criteria can be found in the glossary of the subject guides.

Personal engagement

This criterion assesses the extent to which the student engages with the exploration and makes it their own. Personal engagement may be recognized in different attributes and skills. These could include addressing personal interests or showing evidence of independent thinking, creativity or initiative in the designing, implementation or presentation of the investigation.

Mark	Descriptor
0	The student's report does not reach a standard described by the descriptors below.
1	**The evidence of personal engagement with the exploration is limited with little independent thinking, initiative or insight.** The justification given for choosing the research question and/or the topic under investigation does not demonstrate **personal significance, interest or curiosity.** There is little evidence of **personal input and initiative** in the designing, implementation or presentation of the investigation.
2	**The evidence of personal engagement with the exploration is clear with significant independent thinking, initiative or insight.** The justification given for choosing the research question and/or the topic under investigation demonstrates **personal significance, interest or curiosity.** There is evidence of **personal input and initiative** in the designing, implementation or presentation of the investigation.

Exploration

This criterion assesses the extent to which the student establishes the scientific context for the work, states a clear and focused research question and uses concepts and techniques appropriate to the Diploma Programme level. Where appropriate, this criterion also assesses awareness of safety, environmental, and ethical considerations.

Mark	Descriptor
0	The student's report does not reach a standard described by the descriptors below.
1–2	The topic of the investigation is identified and a research question of some relevance is **stated but it is not focused.** The background information provided for the investigation is **superficial** or of limited relevance and does not aid the understanding of the context of the investigation. The methodology of the investigation is only appropriate to address the research question to a very limited extent since it takes into consideration few of the significant factors that may influence the relevance, reliability and sufficiency of the collected data. The report shows evidence of limited awareness of the significant **safety,** ethical or environmental issues that are **relevant to the methodology of the investigation*.**
3–4	The topic of the investigation is identified and a relevant but not fully focused research question is described. The background information provided for the investigation is mainly appropriate and relevant and aids the understanding of the context of the investigation. The methodology of the investigation is mainly appropriate to address the research question but has limitations since it takes into consideration only some of the significant factors that may influence the relevance, reliability and sufficiency of the collected data. The report shows evidence of some awareness of the significant **safety,** ethical or environmental issues that are **relevant to the methodology of the investigation*.**

Mark	Descriptor
5–6	The topic of the investigation is identified and a relevant and fully focused research question is clearly described. The background information provided for the investigation is entirely appropriate and relevant and enhances the understanding of the context of the investigation. The methodology of the investigation is highly appropriate to address the research question because it takes into consideration all, or nearly all, of the significant factors that may influence the relevance, reliability and sufficiency of the collected data. The report shows evidence of full awareness of the significant **safety,** ethical or environmental issues that are **relevant to the methodology of the investigation*.**

* This indicator should only be applied when appropriate to the investigation. See exemplars in TSM.

Analysis

This criterion assesses the extent to which the student's report provides evidence that the student has selected, recorded, processed and **interpreted** the data in ways that are relevant to the research question and can support a conclusion.

Mark	Descriptor
0	The student's report does not reach a standard described by the descriptors below.
1–2	The report includes **insufficient relevant** raw data to support a valid conclusion to the research question. Some **basic** data processing is carried out but is either too **inaccurate or too insufficient to lead to a valid** conclusion. The report shows evidence of little consideration of the impact of measurement uncertainty on the analysis. The processed data is incorrectly or insufficiently interpreted so that the conclusion is invalid or very incomplete.
3–4	The report includes relevant but incomplete quantitative and qualitative raw data that could support a simple or partially valid conclusion to the research question. Appropriate and sufficient data processing is carried out that could lead to a broadly valid conclusion but there are significant inaccuracies and inconsistencies in the processing. The report shows evidence of some consideration of the impact of measurement uncertainty on the analysis. The processed data is interpreted so that a broadly valid but incomplete or limited conclusion to the research question can be deduced.

Mark	Descriptor
5–6	The report includes sufficient relevant quantitative and qualitative raw data that could support a detailed and valid conclusion to the research question. Appropriate and sufficient data processing is carried out with **the accuracy** required to enable a conclusion to the research question to be drawn that is fully **consistent** with the experimental data. The report shows evidence of full and appropriate consideration of the impact of measurement uncertainty on the analysis. The processed data is correctly interpreted so that a completely valid and detailed conclusion to the research question can be deduced.

Evaluation

This criterion assesses the extent to which the student's report provides evidence of evaluation of the investigation and the results with regard to the research question and the accepted scientific context.

Mark	Descriptor
0	The student's report does not reach a standard described by the descriptors below.
1–2	A conclusion is **outlined** which is not relevant to the research question or is not supported by the data presented. The conclusion makes superficial comparison to the accepted scientific context. Strengths and weaknesses of the investigation, such as limitations of the data and sources of error, are **outlined** but are restricted to an **account of the practical** or **procedural issues** faced. The student has **outlined** very few realistic and relevant suggestions for the improvement and extension of the investigation.
3–4	A conclusion is **described** which is relevant to the research question and supported by the data presented. A conclusion is described which makes some relevant comparison to the accepted scientific context. Strengths and weaknesses of the investigation, such as limitations of the data and sources of error, are **described** and provide evidence of some awareness of the **methodological issues*** involved in establishing the conclusion. The student has **described** some realistic and relevant suggestions for the improvement and extension of the investigation.

Mark	Descriptor
5–6	A detailed conclusion is **described and justified** which is entirely relevant to the research question and fully supported by the data presented. A conclusion is correctly **described and justified** through relevant comparison to the accepted scientific context. Strengths and weaknesses of the investigation, such as limitations of the data and sources of error, are **discussed** and provide evidence of a clear understanding of the **methodological issues*** involved in establishing the conclusion. The student has **discussed** realistic and relevant suggestions for the improvement and extension of the investigation.

*See exemplars in TSM for clarification.

Communication

This criterion assesses whether the investigation is presented and reported in a way that supports effective communication of the focus, process and outcomes.

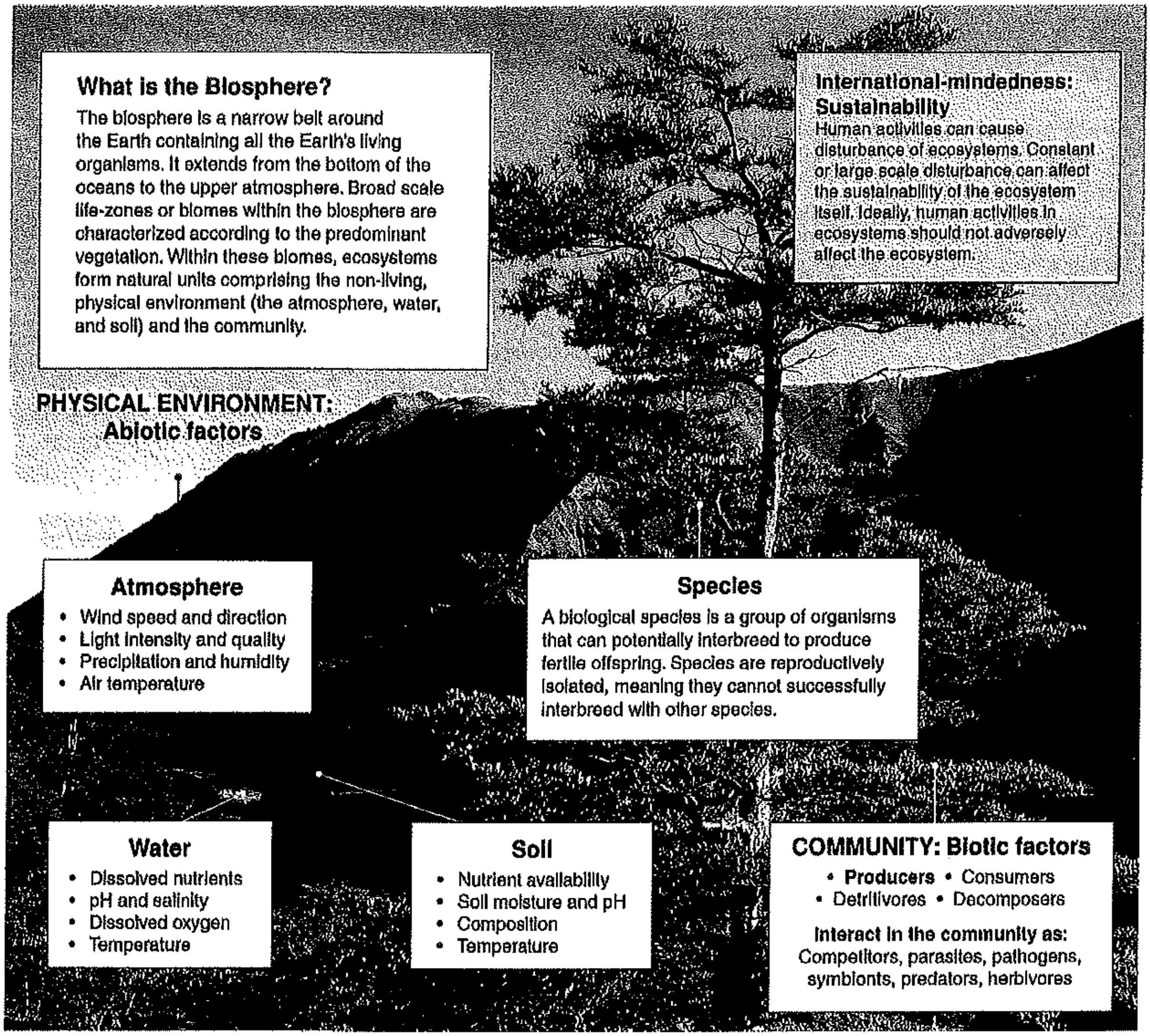
Mark	Descriptor
0	The student's report does not reach a standard described by the descriptors below.
1–2	**The presentation of the investigation is unclear, making it difficult to understand the focus, process and outcomes.** The report is not well structured and is unclear: the necessary information on focus, process and outcomes is missing or is presented in an incoherent or disorganized way. The understanding of the focus, process and outcomes of the investigation is obscured by the presence of inappropriate or irrelevant information. There are many errors in the use of subject-specific terminology and conventions*.
3–4	**The presentation of the investigation is clear. Any errors do not hamper understanding of the focus, process and outcomes.** The report is well structured and clear: the necessary information on focus, process and outcomes is present and presented in a coherent way. The report is relevant and concise thereby facilitating a ready understanding of the focus, process and outcomes of the investigation. The use of subject-specific terminology and conventions is appropriate and correct. Any errors do not hamper understanding.

*For example, incorrect/missing labelling of graphs, tables, images; use of units, decimal places. For issues of referencing and citations refer to the "Academic honesty" section.

116 Components of an Ecosystem

Key Idea: An ecosystem consists of all the organisms living in a particular area and their physical environment.

An **ecosystem** is a community of living organisms and the physical (non-living) components of their environment. The community (living component of the ecosystem) is in turn made up of a number of **populations**, these being organisms of the same species living in the same geographical area. The structure and function of an ecosystem is determined by the physical (abiotic) and the living (biotic) factors, which determine species distribution and survival.



123RF Tomas Sobek

1. Distinguish clearly between a community and an ecosystem: ____________________

2. Distinguish between biotic and abiotic factors: ____________________

3. Use one or more of the following terms to describe each of the features of a beech community listed below:
Terms: *population, community, ecosystem, physical factor.*

(a) All the beech trees present: __________ (c) All the organisms present: __________

(b) The entire forest: __________ (d) The humidity: __________

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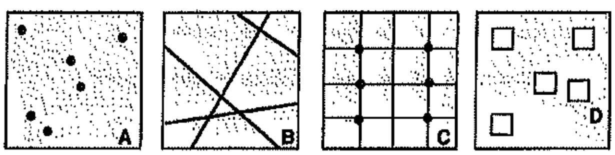
Measuring the Diversity of Ecosystems

In most field studies, it is not possible to measure or count every member of a population. Instead, the population is sampled in a way that provides a fair (unbiased) representation of the organisms present and their distribution. This is usually achieved through **random sampling**, a technique in which every possible sample of a given size has the same chance of selection.

Students sampling an intertidal community

The methods you use to sample must be appropriate to the community being studied and the information you want to obtain. You must also think about the time and equipment available, the organisms involved, and the impact your study might have on the environment. Communities in which the populations are at low density and have a random or clumped distribution will require a different sampling strategy to those in which the populations are uniformly distributed and at higher density. There are many sampling options, each with advantages and drawbacks for particular communities. Quadrats are often used to sample communities of plants and invertebrates and can be placed randomly or along a transect (below).

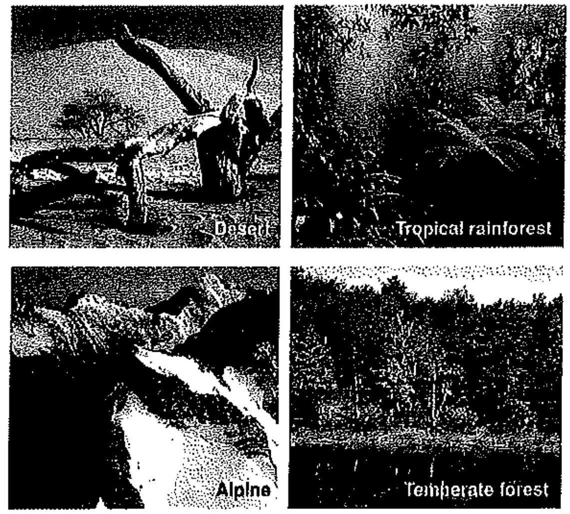


Random point sampling | *Line and belt transects* | *Point sampling: systematic grid* | *Random quadrats*

Random sampling is achieved using random number tables which provide points on a grid (A) or pairs of coordinates which are joined to form a line (B). Random sampling produces an unbiased result and can be used to sample large population, but it can provide a poor representation of the area if not enough samples are taken. Systematic sampling (C) has more bias but provides good coverage of the sample area. Quadrats (D) can used for point sampling or transects.

Types of Ecosystems

Ecosystems vary greatly in their features, from dry, inhospitable environments with very little vegetation, to lush tropical rainforests containing many different types of vegetation. Each ecosystem has a unique combination of abiotic factors, which collectively influence its community structure.



Geographical Barriers can Isolate Species

Species found on almost every continent of the world are called cosmopolitan species. Examples include wild pigeons, house sparrows, brown (or Norway) rats, and the housefly. Although they are the same species, if the populations are separated by a significant barrier (e.g. mountains, oceans) or on different continents, they will not be able to interbreed. Long term isolation can eventually lead to differences between populations. In some cases, these differences may result in reproductive isolation and the formation of a new species. The distribution of the brown rat is shown in dark grey below.

4. (a) What is a biological species? ______________________________

____

(b) Why are the two brown rat populations (A and B) still considered to be the same species?

____

5. (a) What is meant by random sampling? ______________________________

____

(b) Why is it usually recommended that population sampling is random? ______________________________

____

____

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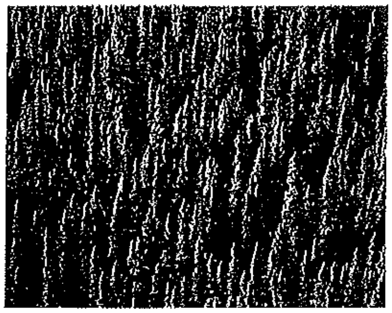
117 The Stability of Ecosystems

Key Idea: Ecosystems have the potential to remain stable, i.e. in a relatively unchanged state, over long periods of time. Although the biotic and abiotic components of ecosystems are constantly responding to environmental changes, ecosystems as a whole are potentially stable (unchanging) for long periods of time. The long term stability of an ecosystem depends partly on its ability to resist change and recover from disturbance (its resilience). Human activity can alter the long term unchanging nature of ecosystems by interfering with important aspects of ecosystem function, such as nutrient cycling. These effects can be investigated on a small scale using experimental systems called mesocosms.

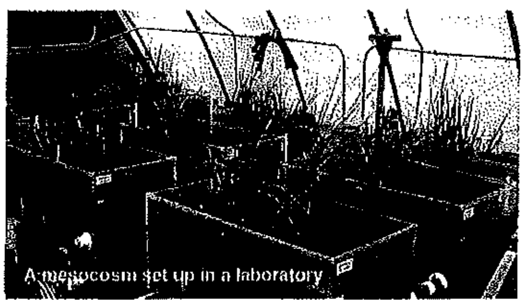


An ecosystem may remain stable for many hundreds or thousands of years provided that the biotic and abiotic components interacting within it remain stable.

Small scale disturbances usually have a minor ecosystem effect. Fire or flood may destroy some parts, but enough is left for the ecosystem to return to its original state.

Large scale disturbances such as volcanic eruptions, sea level rise, or large scale open cast mining remove all components of the ecosystem, changing it forever.

Experimental Systems Can Model Ecosystem Functions



A mesocosm set up in a laboratory

NOAA

Aspects of ecosystem function, including responses to changes in inputs and long term stability, can be investigated using physical representations of ecosystems called **mesocosms**. Examples include artificial ponds and streams, or enclosed areas of land, wetland, or ocean. Some mesocosm studies allow a natural community to be studied *in situ* (in place), but still allow the researcher to control the environmental conditions. Others are carried out at research facilities in specially designed containers.

Mesocosms can be open or sealed (enclosed) systems. Sealed mesocosms allow the researcher to fully control the experimental conditions, including the entry and exit of matter. Mesocosms, especially small ones, are generally not stable in the long term, and change over time as a result of their smaller scale and isolated nature.

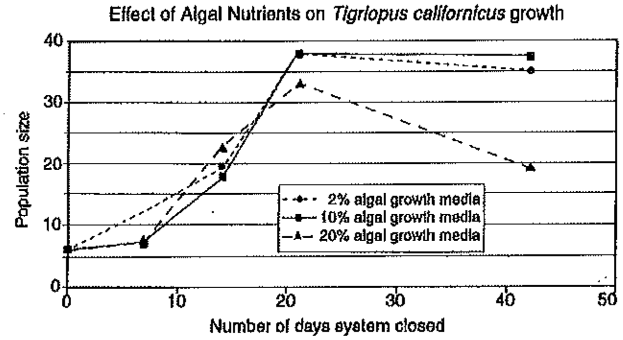
A Mesocosm Study

Small, closed ecological chambers were used by researchers at the University of Washington to test system responses to changes in environment and inputs. One aspect of the study is described here.

Researchers altered the levels of algal growth nutrients added to the mesocosm chambers and measured the effect of the algal response on the population growth of a marine copepod (*Tigriopus californicus*).

Algal growth-promoting medium was added at 2, 10, or 20% to seawater, together with 0.1 mL of an algal mix. Two days after adding the growth medium and algae, six copepods were added to each chamber. The chambers were sealed and the population size in each mesocosm was measured over time (results below).

Effect of Algal Nutrients on *Tigriopus californicus* growth



Adapted from Armentrout, B & Kappes, H; University of Washington with corrections

1. Analyse the data in the graph (above right). Describe the results and comment on the stability of each chamber: ______

2. What assumptions are made in this experiment? ______

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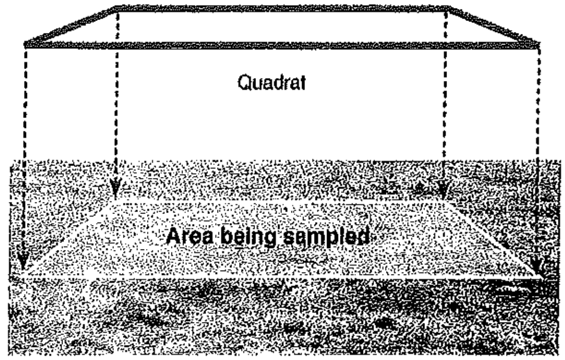
118 Quadrat Sampling

Key Idea: Quadrat sampling involves a series of random placements of a frame of known size over an area of habitat to assess the abundance or diversity of organisms.

Quadrat sampling is a method by which organisms in a certain proportion (sample) of the habitat are counted directly. It is used when the organisms are too numerous to count in total. It can be used to estimate population **abundance** (number), **density, frequency of occurrence**, and **distribution**. Quadrats may be used without a transect when studying a relatively uniform habitat. In this case, the quadrat positions are chosen randomly using a random number table.

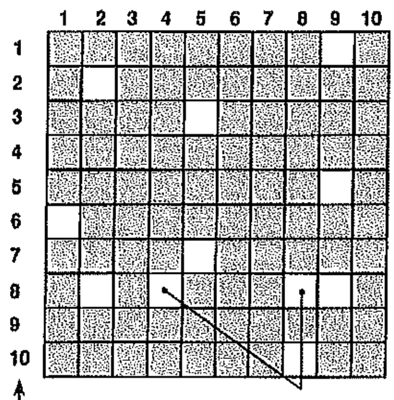
The general procedure is to count all the individuals (or estimate their percentage cover) in a number of quadrats of known size and to use this information to work out the abundance or percentage cover value for the whole area.



$$\text{Estimated average density} = \frac{\text{Total number of individuals counted}}{\text{Number of quadrats} \times \text{area of each quadrat}}$$

Guidelines for Quadrat Use:

1. The **area of each quadrat** must be known exactly and ideally quadrats should be the same shape. The quadrat does not have to be square (it may be rectangular, hexagonal etc.).
2. **Enough quadrat samples** must be taken to provide results that are representative of the total population.
3. **The population of each quadrat** must be known exactly. Species must be distinguishable from each other, even if they have to be identified at a later date. It has to be decided beforehand what the count procedure will be and how organisms over the quadrat boundary will be counted.
4. The size of the quadrat should be appropriate to the organisms and habitat, e.g. a large size quadrat for trees.
5. The quadrats must be **representative of the whole area.** This is usually achieved by **random sampling** (right).

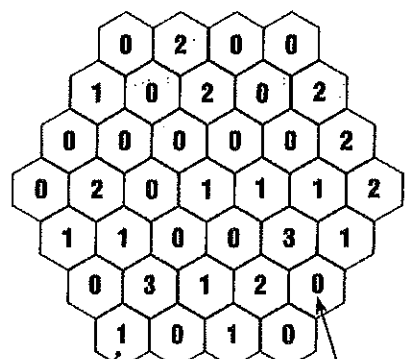


The area to be sampled is divided up into a grid pattern with indexed coordinates

Quadrats are applied to the predetermined grid on a random basis. This can be achieved by using a random number table.

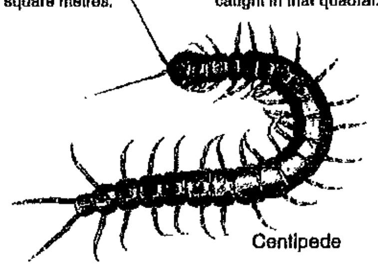
Sampling a centipede population

A researcher by the name of Lloyd (1967) sampled centipedes in Wytham Woods, near Oxford in England. A total of 37 hexagon-shaped quadrats were used, each with a diameter of 30 cm (see diagram on right). These were arranged in a pattern so that they were all touching each other. Use the data in the diagram to answer the following questions.



Each quadrat was a hexagon with a diameter of 30 cm and an area of 0.08 square metres.

The number in each hexagon indicates how many centipedes were caught in that quadrat.



Centipede

1. Determine the average number of centipedes captured per quadrat:

___

2. Calculate the estimated average density of centipedes per square metre (remember that each quadrat is 0.08 square metres in area):

___

3. Looking at the data for individual quadrats, describe in general terms the distribution of the centipedes in the sample area:

___

___

4. Describe one factor that might account for the distribution pattern:

___

___

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120 Using the Chi-Squared Test in Ecology

Key Idea: The chi-squared test is used to compare sets of categorical data and evaluate if differences between them are statistically significant or due to chance.

The chi-squared test (χ^2) is used to determine differences between categorical data sets when working with frequencies (counts). For the test to be valid, the data recorded for each categorical variable (e.g. species) must be raw counts (not measurements or derived data). The chi-squared test is used for two types of comparison: test for goodness of fit and tests of independence (association). A test for goodness of fit is used to compare an experimental result with an expected theoretical outcome. You will perform this test later to compare the outcome of genetic crosses to an expected theoretical ratio. A test for independence evaluates whether two variables are associated. The chi squared test is not valid when sample sizes are small (<20). Like all statistical tests, it aims to test the null hypothesis; the hypothesis of no difference (or no association) between groups of data. The worked example below uses the chi-squared test for association in a study of habitat preference in mudfish.

Using the Chi-Squared Test for Association

Black mudfish (*Neochanna diversus*) is a small fish species native to New Zealand and found in wetlands and swampy streams. Researchers were interested in finding environmental indicators of favourable mudfish habitat. They sampled 80 wetland sites for the presence or absence of mudfish and recorded if there was emergent vegetation present or absent. Emergent vegetation, defined as vegetation rooted in water but emerging above the water surface, is an indicator of a relatively undisturbed environment. A chi-squared for association was used to test if mudfish were found more often at sites with emergent vegetation than by chance alone. The null hypothesis was that there is no association. The worked example is below. The table of observed values records the number of sites with or without mudfish and with or without emergent vegetation.

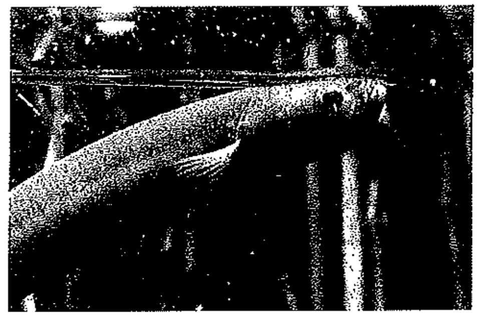

Photo and data: Rhys Barrier, University of Waikato

Black mudfish are able to air-breathe and can survive through seasonal drying of their wetland habitat.

Step 1: Enter the observed values (O) in a contingency table

A χ^2 test for association requires that the data (counts or frequencies) are entered in a **contingency table** (a matrix format to analyse and record the relationship between two or more categorical variables). Marginal totals are calculated for each row and column and a grand total is recorded in the bottom right hand corner (right).

	Mudfish absent (0)	Mudfish present (1)	Total
Emergent vegetation absent (0)	15	0	15
Emergent vegetation present (1)	26	39	65
Total	41	39	80

Step 2: Calculate the expected values (E)

Calculating the expected values for a contingency table is simple. For each category, divide the row total by the grand total and multiply by the column total. You can enter these in a separate table or as separate columns next to the observed values (right).

	Mudfish absent (0)	Mudfish present (1)	Total
Emergent vegetation absent (0)	7.69	7.31	15
Emergent vegetation present (1)	33.31	31.69	65
Total	41	39	80

Step 3: Calculate the value of chi-squared (χ^2) of $(O - E)^2 \div (E)$

The difference between the observed (O) and expected (E) values is calculated as a measure of the deviation from a predicted result. Since some deviations are negative, they are all squared to give positive values. This step is best done as a tabulation to obtain a value for $(O - E)^2 \div (E)$ for each category. The sum of all these values is the value of chi squared (blue table right).

$$\chi^2 = \sum \frac{(O-E)^2}{E}$$

Where: O = the observed result
E = the expected result
Σ = sum of

Category	O	E	O–E	$(O-E)^2$	$\frac{(O-E)^2}{E}$
Mudfish 0/EmVeg 0	15	7.69	7.31	53.44	6.95
Mudfish 1/EmVeg 0	0	7.31	-7.31	53.44	7.31
Mudfish 0/EmVeg 1	26	33.31	-7.31	53.44	1.60
Mudfish 1/EmVeg 1	39	31.69	7.31	53.44	1.69
Total = 80				χ^2 →	Σ = 17.55

Step 4: Calculate the degrees of freedom (df)

The degrees of freedom for a contingency table is given by the formula: (rows-1) x (columns-1). For this example, degrees of freedom (df) is therefore (2-1) x (2-1) = 1.

Step 5: Using the chi squared table

On the χ^2 table (relevant part reproduced in the table right) with 1 degree of freedom, the calculated value for χ^2 of 17.55 corresponds to a probability of less than 0.001 (see arrow). *This means that by chance alone a χ^2 value of 17.55 could be expected less than 0.1% of the time.* This probability is much lower than the 0.05 value which is generally regarded as significant. The null hypothesis can be rejected and we have reason to believe that black mudfish are associated with sites with emergent vegetation more than expected by chance alone.

Critical values of χ^2 at different levels of probability. By convention, the critical probability for rejecting the null hypothesis (H_0) is 5%. If the test statistic is greater than the tabulated value for P = 0.05 we reject H_0 in favour of the alternative hypothesis.

	Level of Probability (P)				
df	0.05	0.025	0.01	0.005	0.001
1	3.84	5.02	6.63	7.88	10.83 →
2	5.99	7.38	9.21	10.60	13.82
3	7.81	9.35	11.34	12.84	16.27

REFER LINK 266

Guidelines for the use of animals in IB World Schools

Why have guidelines for use of animals in the classroom?

As respect for animals is a fundamental stepping stone in the development of respect for fellow human beings the IB animal guidelines seek to set out the parameters for the acceptable inclusion of animals in an IB World School.

What do the guidelines apply to?

These guidelines apply to the treatment of all animals in IB World Schools, to all students at all levels including PYP, MYP, DP and IBCC whether assessed or non- assessed, for extended essays, the group 4 project and the MYP project. The Guidelines cover any work, be it in classrooms or school laboratories, or in the general environment, that is anywhere where IB students may be working. The Guidelines apply to:

1. Keeping animals in schools
2. Animal Experimentation
3. The use of human subjects in investigations

The Guidelines

Keeping live animals in the classroom

Caring for classroom pets can provide a variety of authentic learning contexts for students at almost every level. It presents opportunities for students to develop compassion and empathy towards other living things and take action as a result of this learning. Ultimately the decision to care for a live animal lies with the classroom teacher and time should be taken to adequately research the animal and determine a suitable diet, housing, exercise and socialization for the animal as well as how its care fits into the curriculum. The following should be carefully considered before committing to the care of a classroom pet:

- Student sensitivity or allergies to particular species, their food or bedding materials
- Type of animal (domestic rather than wild, not venomous or vicious, diurnal rather than nocturnal etc)
- Arrangements for housing the animal safely, comfortably, cleanly and in a manner that is not disruptive to the classroom environment
- Arrangements for appropriate care of the animals over weekends and holidays
- Long term care of the animal in cases where a future student is allergic or the animal can no longer live in the classroom

Additionally, essential agreements should be established regarding when and how the animal is to interact with students. These should ensure the health and safety for both students and the animal (e.g. students wash their hands before and after handling).

The nature of the guidelines

IB animal experimentation guidelines may be more stringent than some local or national standards for experimentation in schools. Our standards for work in schools should also be more stringent than those of university and research and development committees as we are not carrying out essential, groundbreaking research. Practical work in schools has other purposes such as reinforcing concepts and teaching practical skills and techniques. Even in a practically based extended essay the work will not be fundamental, ground-breaking research.

Live animals in experimentation

Any planned and actual experimentation involving live animals must be subject to approval by the teacher following a discussion between teacher and student(s) based on the IB guidelines. This discussion should look at the 3Rs principle and the decision justified. The principles are:

- Replacement
- Refinement
- Reduction

Any investigation involving animals should initially consider the replacement of animals with cells or tissues, plants or computer simulations. If the animal is essential to the investigation refinements to the investigation to alleviate any distress to the animal and a reduction in the numbers of animals involved should be made.

Experiments involving animals must be based on observing and measuring aspects of natural animal behaviour. Any experimentation should not result in any cruelty to any animal, vertebrate or invertebrate. Therefore experiments that administer drugs or medicines or manipulate the environment or diet beyond that which can be regarded as humane is unacceptable in IB schools.

Animal dissection

There is no requirement in the PYP, MYP or in the DP group 4 sciences for students to witness or carry out a dissection of any animal, vertebrate or invertebrate. If teachers believe that it is an important educational experience and wish to include dissections in their scheme of work they must apply the following guidelines. The IB does not support animal dissection or the use of animal body parts in the PYP.

- Discuss reasons for dissections of whole animals with the students.
- Allow any student who wishes to opt out of the dissection to do so.
- Seek to reduce the number of dissections.
- Seek to replace animal dissection with computer simulations and/or use animal tissue, for example, hearts and lungs obtained from butchers, abattoirs or laboratory suppliers.
- Dissect animals obtained from an ethical source only, for example, no wild animals, animals killed on the road or endangered animals.

Experiments involving human subjects

Any experimentation involving human subjects must be with their direct, legally obtained written permission and must follow the above guidelines. In addition, the investigation must not use human subjects under the age of 16 without the written consent of the parents or guardians.

- Subjects must provide written consent
- The results of the investigation must be anonymous
- Subjects must participate of their own free will
- Subjects have the right to withdraw from the investigation at any time.

Investigations involving any body fluids must not be performed due to the risk of the transmission of blood-borne pathogens. An exception would be an investigator using their own saliva or sweat.

The use of secondary data

Secondary data acquired as a result of research that would not be in line with the above policy may be used under certain circumstances:

- Data acquired by professional researchers. In this case the data would be from research which is written up in academic journals and qualifies as ground breaking. Such research would have been presented to research committees for approval and be licensed.
- Research which was considered ethical at the time the research was conducted. Our view of animals and their welfare has moved on considerably in recent years. Much research conducted in a different culture would not be granted permission today even though at the time, it was considered acceptable. Data from such sources is acceptable.

Some secondary data exists that was considered unethical even within the cultural and historical context of the day. Such data is not acceptable under any circumstances.

What happens if the guidelines are not followed?

Internal assessment moderators or extended essay examiners who see evidence that the guidelines are not being followed at the school, in the sample work sent for moderation or in extended essays are required to complete a problem report form (PRF) to be submitted to IB Cardiff.