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Conversion Immersion: Adapting Labs for Online or On-Campus Use

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While on-campus and online domains both offer opportunities for teaching and learning biology, they have unique and shared challenges with respect to involving students in practical work. The subject knowledge, reasoning, and practical skills that we want students to practice, however, remain constant. A high-quality lab is usually one that captures these elements; if we have such a lab in place in one environment, it makes sense to start from there when building a lab for use in the other environment. In this workshop, we worked with participants to help them convert their labs for use in a new domain.

Keywords: bioinformatics

Introduction

When teaching biology in both online and on-campus environments, it quickly becomes apparent that while both domains offer their own opportunities for teaching and learning, both domains also have some unique and some shared challenges when it comes to involving students in practical work. The kinds of subject-specific knowledge, reasoning, and practical skills that we want students to practice, however, remain constant. A high-quality lab is usually one that captures these elements, and if we have such a lab in place in one environment, it makes sense to start from there when trying to build an equivalent lab for use in the other environment.

Over the past seven years, in working with both on-campus and online versions of Introductory Biology, we have developed labs for both settings using a variety of approaches:

- •developing entirely new labs for either the online or on-campus class;
- •translating existing on-campus or online labs for use in similar form in the other domain;
- •using an existing lab in one domain as the inspiration for a new lab in the other domain, and developing this new lab in a way that emphasizes similar pedagogical goals while being quite different in structure or in specific biological content; and
- •having used a 'classic' lab as the source/inspiration when developing a lab in the other domain, then using this newly-made lab as source/inspiration for making changes to the original lab.

Taken together, we understand our approach to lab development as a sort of 'dynamic equilibrium' characterized by ongoing two-way movement of ideas and goals between the on-campus and online domains of practice. This approach is based in our own awareness of the differences and challenges to learning characteristic of each domain, as well as in a confidence in the possibilities for significant learning experiences in either domain.

With the rise in online learning, there has been much discussion of the relative effectiveness of online and on-campus settings as places to learn and teach. We will not attempt to capture this discussion here; however, the 2009 meta-analysis undertaken for the United States Department of Education (Means *et al.*, 2009) is relevant to such conversations, having found from a review of research studies that online instruction compared favorably to on-campus instruction – while stressing that very few of the studies uncovered in their literature search process met their criteria that studies be either experimental or quasi-experimental with controls. Some other recent work has looked more closely at online lab work in biology learning specifically: for example, Weisman (2010) describes online bioinformatics labs that require students to navigate the same set of software tools used by bioinformatics researchers, while Shegog *et al.* (2011:875) describe "virtual transgenics" activities in which students learn molecular biology in an online environment.

The effectiveness of a particular learning setting is likely influenced quite a bit by the work that students are asked to do within that setting. To foster thinking along these

lines, we recommended to workshop participants two particularly useful recent readings, both instances of trying to move past the basic question of effectiveness of online learning: de Jong *et al.* (2013) compare examples of traditional and virtual labs and discusses how they can be combined to strengthen the learning experience (with emphasis on design to ensure valid learning), while Friesen (2011) considers the nature of experience for students and teachers working within these two different settings, in the process identifying some important considerations for design and teaching off- and online. Two other recent articles that might be of interest to ABLE members are Friesen's (2012) discussion about virtual dissections and some key characteristics of online lab experiences, and a thoughtful study by Zumbach *et al.* (2006) describing another virtual environment for learning lab work in molecular biology. Zumbach *et al.* (2006) question whether the often greatly-simplified experiments undertaken in traditional school science are giving students an authentic experience of research, and suggest that a virtual environment can "have the potential to deal with the complexity of real science" (Zumbach *et al.*, 2006: 298) at a level appropriate for a given group of students.

Inspired by past "conversion immersion" sessions at ABLE meetings (Hoefnagels & Walvoord, 2005; Hoefnagels & Walvoord, 2007; Brickman & Armstrong, 2009; Walvoord & Hoefnagels, 2011), in this workshop we worked with participants to help them convert their labs for use in a new domain. We presented examples of labs that we have cross-developed for our on-campus and online versions of Introductory Biology, using them to illustrate what we consider to be the most important considerations and decisions when adapting. Participants worked together and with us to identify the most valuable goals of the practical work that should be maintained regardless of domain, to identify the most easily-adaptable aspects of their own labs, and to work on solutions for more challenging aspects. Ideally, beginning this cross-adaptation will set up a dynamic equilibrium between the two domain-specific versions of the lab, with lessons learned from offering a lab in both domains resulting in ongoing improvements to both lab versions.

Notes for the Instructor

Workshop Methods

Our goal for this workshop was for participants to spend some focused, collaborative time thinking about how to convert specific labs from one domain – either on-campus or online – to the other, and to come away from the workshop with some solid ideas to pursue.

To prepare for the workshop, we contacted participants in advance by e-mail[1] and asked them to identify specific labs that they were planning to work on, and to find out which format (on-campus or online) they were interested in converting to.

We used this information to sort the participants into groups based on their subject area of interest. The workshop itself was organized into three parts: Introduction and Whole-Group Discussion, Small-Group Set 1, and Small-Group Set 2. A copy of the Workshop Outline circulated to participants is included in Appendix A. Each part of the workshop featured discussions guided by focus questions that we provided, and the Small-Group Sets included specific goals that we suggested the participants try to achieve. For each discussion, participants were provided with a sheet containing question prompts and space to record their ideas (Appendix B). These sheets were collected, photocopied, and returned to the participants by the end of the workshop. We recorded contributions on the chalkboard during the Whole-Group Discussion, and circulated among the smaller groups to facilitate discussion during the Small-Group Sets.

Introduction and Whole-Group Discussion

We began by introducing ourselves and describing our interest in and experience with cross-developing labs for on-campus and online classes.

For the first whole-group discussion, we directed the conversation away from the relative merits or features of online or on-campus learning, and instead asked participants to think about and share their responses to a fundamental question that participants at an ABLE meeting would be in a good position to answer: "Why do labs?" We also included alternate forms of this question as prompts: What is lab for? Why do we have labs? What should happen in the lab component of a class? What should students be learning in labs?

We then turned the discussion toward the question of "Why do labs online?", followed by a brief review of our work in converting labs between domains. Participants were supplied with hard copies of our on-campus labs and links to our online labs for reference (Appendix C).

After recording the group's responses to the first two questions on the chalkboard, we presented what we called our "strengths list" (Table 1): a table describing how, based on our own experience and on some published accounts (see Introduction and references therein), the on-campus and online domains each have potential in particular areas that are important to us when teaching labs.

The lists in Table 1 emphasize the relative strengths each domain seems to offer for some of the goals we have for any lab, particularly those related to giving students experience in some important aspects of scientific practice. These aspects, which were so strongly emphasized in participants' responses to "What is lab for?", seem to us to be essential to capture in any lab experience, and the practical question then becomes how we might best design labs in either domain, or across both domains, to give students access to the kinds of scientific experiences we think are most important.

After presenting Table 1, we organized participants for the first Small-Group set.

Small-Group Set 1: Participants with Similar Lab Topics

1 ABLE conference participants are required to select major workshops upon registration for the conference; registration typically closes two weeks before the conference begins.

Table 1. Strengths of two learning environments

On Campus	Online
physical manipulation of specimens and equipment	long-term data and more complex studies
richer sensory experience	web-based/software tools for certain aspects of biological practice
immediacy and complexity of environments and phenomena	access to phenomena, techniques, places of scientific work
social interactions group work (e.g. in designing experiments) real-time feedback from TA / instructor / peers	social interactions peer review asynchronous discussion potentially larger and more diverse group
diversity of interactions with the environment	independent work
unpredictable or open-ended activities	continuity of experience
routine (mundane?) lab skills and troubleshooting	do-overs

In this section of the workshop, participants were assigned to groups based on the topic of the lab they were interested in converting, so that each group included two to four participants interested in a common lab topic. The task for this discussion was to identify a 'keeper' element of the lab to convert. Additional prompt questions were:

- Looking back to the "What is lab for?" list, which elements will you choose to do really well in the lab that you've chosen to convert?
- What particular element that you want to retain in the converted lab will you work on today? What can you leave behind? What is this lab *really* about, or what *could* it be about?
- How will you handle logistical elements such as presenting instructions and data as well as submission of student work?

We circulated among the small groups to answer questions and facilitate discussion. The 'quick reports' referred to in the workshop outline (Appendix A) were omitted from the workshop schedule for lack of time.

Small-Group Set 2: Participants with Different Lab Topics

For the second small-group set, participants were placed in new groups at random to address the goal of identifying one domain-specific challenge to converting their lab. Additional prompt questions were:

- What aspect of this lab will be the most challenging to include in the new environment? How could you deal with this challenge?
- What are you worried about losing or not being able to do? What do you think you will gain or be able to do better?
- Any additions or changes to suggest for the 'strengths' list (Table 1)?

We again circulated among the small groups to answer questions and facilitate discussion. 'Quick reports' were omitted.

Workshop Results

All three sections of the workshop generated rich discussion in both the morning and afternoon workshops. All but one of the workshop participants were interested in converting their labs from face-to-face to online delivery; the remainder of this paper reflects the groups' primary interest.

Whole-Group Discussion

Table 2 combines the responses from morning and afternoon workshop groups.

A number of themes emerged from this discussion: we do labs in order to give students the opportunity to experience science as a practice by engaging in scientific reasoning, undertaking experiments and making observations, interpreting and communicating, and working together. We do labs to help students see the value, difficulty, and excitement of doing science, and to help them make sense of the conceptual content of science, including such foundational notions as variability.

Having reminded ourselves why we might do labs, the whole-group conversation then turned to the question of why we might do labs online. Table 3 combines the morning and afternoon session participants' responses to this question.

Table 2. Participant responses to the question "What is lab for?"

What is lab for?
learning to observe
collecting / analyzing data
to make mistakes / have things not work
deeper understanding of biology content, helping to making sense of / adding detail to biological concepts
hands-on / real-world experience with equipment and techniques
to do science instead of hearing the result
social facilitation and collaboration, particularly through group work
base conclusions on evidence
learn experimental design and role of controls
encourage critical thinking and inquiry
execute written/verbal directions
communication skills (written/verbal)
different source of assessment than lecture
expose and address misconceptions
get students excited and aware of the relevance of science and scientific methods to students' own lives
remove fear of working in a scientific environment, getting experience of scientific practice / work: by "testing the waters" students can decide if they want to / can do science
exploration, curiosity, new experiences
different view of unpredictability / variability
manipulate and test concepts to allow a deeper understanding

Two related themes emerged in participants' responses to "Why do labs online?": practicality and access. Online labs could allow for much greater flexibility in terms of scheduling, allowing more students to access the courses in which the labs are offered, as well as providing opportunities for supplemental, preparatory, and make-up labs. As well, online labs could give students access to aspects of scientific work that are for various reasons impractical to provide in an on-campus lab: they could undertake longer-term studies as well as learn about the use of techniques and equipment that are perhaps too expensive or dangerous to provide to students in an on-campus lab, enriching their experience of scientific work.

Small-Group Set 1: Participants with Similar Lab Topics

We organized the small groups (two to four participants per group) based on participants' reported lab topics or general area of interest, as summarized in Table 4. Some participants reported interest in a number of lab topics, any of which they were willing to work with during the workshop; this is reflected in the diversity of topics within some groups.

The stated goal for the first Small-Group set was for participants to identify and convert one 'keeper' aspect of their lab for use in the alternate environment. Responses to the guiding questions are summarized here; feedback from participants in the morning and afternoon workshops are combined.

Looking Back to the "What is Lab For?" List, Which Elements Will You Choose to do Really Well in the Lab That You've Chosen to Convert?

Participants' responses to this question emphasized higher-order conceptual objectives including scientific inquiry, basic knowledge-building, understanding theoretical concepts, scientific literacy, and confronting misconceptions. Participants also referred to process skills such as collaboration, communication, experimental design, and data collection and analysis. One participant cited "equipment skills" as a goal to achieve, but did not specify the type of equipment. The single participant who was interested in converting a lab from an online to a hybrid environment wished to facilitate the experimental design component online as a group activity, while the experiment itself was performed by the students offline.

Table 3. Participant responses to the question "Why do labs online?"

Why do labs online?
flexibility in scheduling / efficient use of lab rooms
studies using [expensive] equipment, long-term studies, work that would be too dangerous for on-campus use
access to lab work
◦ without coming to campus
◦ for students with disabilities
◦ for students whose life circumstances don't permit a regular classroom schedule
opportunity to work with new and modern scientific tools/practices
self-pacing / student-centred; scientific work could be done at home
larger class sizes, beyond physical space and staffing; could save money (?) e.g. on equipment/supplies
enrichment / excitement
element of blended or hybrid courses
labs don't get cancelled; could be used as make-up labs or for students repeating a class
practice / pre-lab / supplemental / getting up to speed
practical alternative to traditional labs

What Particular Element that You Want to Retain in the Converted Lab Will You Work on Today? What Can You Leave Behind? What is This Lab Really About, or What Could it be About?

Participants acknowledged that, in their particular contexts, they could omit equipment skills (handling enzymes, microscopy, and spectrophotometer use were cited specifically) and face-to-face interactions (including group field trips, peer-to-peer work, just-in-time feedback, TA-guided discussions, and class discussions) from their lab activities in the conversion from

on-campus to online. Aspects of the labs that could be retained and emphasized included questions and scenarios to foster engagement, enforcement of theoretical concepts, experimental design, and several aspects of data collection, sharing, analysis, and communication.

The participants also suggested some specific tools and strategies for either replacing or representing anew what they might lose from their labs during the conversion process. Suggested tools and strategies included online discussion boards, self-guided field trips, photo galleries, ImageJ[2] , having students culture samples from themselves or from their environments, use of commercial lab kits (see Appendix A for suppliers), and the use of paint chips instead of spectrophotometers. There was some acknowledgement that the online tools would in some ways carry their own benefits, such as allowing students time to think before participating in discussions, and providing richer data in the form of numerical data sets or photographs.

How Will You Handle Logistical Elements Such as Presenting Instructions and Data as Well as Submission of Student Work?

Responses to this question focused heavily on video presentation (i.e., screencasting[3]) and photo submission; the former primarily for the communication of instructions and techniques, and the latter as evidence of students' work. Assessment options included conventional worksheets (though electronic rather than hard copy), quizzes, and discussion boards. Any learning management system (e.g. Blackboard Learn, D2L, Canvas) includes quiz and discussion tools and can facilitate content delivery and student submissions. Quizzes were also mentioned as a safety measure to ensure understanding and compliance with protocol before students would be allowed to proceed with the lab. Web conferencing was suggested as a synchronous option for students to confer with their teaching assistants. For some participants, it was feasible to consider assembling supplies for students to borrow for home use.

Small-Group Set 2: Participants with Different Lab Topics

For the second Small-Group set, participants were randomly reassigned to new groups to focus on questions related to specific challenges or concerns they had about converting their labs. Responses for the morning and afternoon sessions of the workshop to the guiding questions are combined.

What Aspect of this Lab Will be the Most Challenging to Include in the New Environment? How Could You Deal with This Challenge?

2 ImageJ is Java-based image processing and analysis software; http://imagej.nih.gov/ij/

3 A screencast is a real-time recording of one's computer screen, including audio narration if desired.

Table 4. Lab topics used to place workshop participants into small discussion groups.

Workshop	Group	Lab Topic(s)
morning	1	plant diversity ecosystems soil respiration/carbon cycle/climate change
	2	enzyme function species interactions (microorganisms) vertebrate metabolic activity effects of pH on trypsin
	3	microbiology introductory microbiology antibiotic resistance
	4	introductory techniques equipment and techniques
	5	measurement tools and graphing graphing, basic biochemistry molecular biology, biochemistry
	6	dominance hierarchies phylogeny and taxonomy enzyme specificity membrane function mitosis
afternoon		
	1	forest succession germination environmental science nutrition
	2	plant structure and function protist diversity
	3	cell biology

Participants had two primary concerns: (1) maintaining hands-on activity and (2) fostering communication in the online environment. Suggestions for addressing the former included careful selection of the techniques and procedures that would be required of the students, provision of checklists, use of lab kits (though this introduces the additional challenge of extra fees), and demonstration with videos and photos. Participants suggested that providing etiquette guidelines would help with peer-to-peer interactions, but one participant was concerned about how to manage a process-of-science lab with TA feedback at timely intervals in the online environment. Similarly, the participant who wanted to convert his online lab to a hybrid lab was concerned about coordinating face-to-face planning and discussions around lab investigations that students performed off-campus.

What are You Worried About Losing or not Being Able to do? What do You Think You Will Gain or be Able to do Better?

In terms of potential losses, there were concerns about the social aspects of performing lab activities on campus: team dynamics and problem-solving, communication among group members, oversight of group work, and face-to-face interaction between the professor and the students. There was also some concern for the loss of real equipment (microscopes were cited specifically) and real organisms (trees were cited specifically).

With respect to gains, several participants suggested that the online environment would allow for greater flexibility in scheduling and more time for students to complete laboratory activities. The opportunity for independent student work was suggested as a benefit. The idea of flexibility extended to the design of the lab itself, allowing for a greater scope and variety of data, including "incorrect" data, to be presented to or collected by students. Participants acknowledged the potential for more and easier collaboration among students, both through the use of asynchronous communication tools and through the structure of defined student roles. On the practical side, one participant felt that the presentation of lab protocol was more thoroughly accomplished online than on-campus.

One participant suggested that engagement and motivation could be achieved equally well in both on-campus and online environments.

Any Additions or Changes to Suggest for the 'Strengths' List?

Participants focused their discussion on the other guiding questions for this section of the workshop; responses to this question were few (aseptic technique awareness, computer-based simulations and data analysis, and observations and write-ups) and are encompassed by items already appearing in Table 1.

Conclusions

Deciding to adapt a lab for use in a very different learning and teaching environment turns out to be an ideal opportunity for reflection on the most basic questions related to lab design: Why do we do labs? What are we hoping students will know, do, and learn? What are the key aspects of scientific practice that can (and cannot) be included in a particular lab, and what will this experience be like for students?

During the morning and afternoon workshop sessions, participants approached these questions thoughtfully and practically. In particular, the discussion of why we might offer labs online resulted in the groups carefully considering not just their own ideals for teaching labs, but also the realities of life both for students hoping to study biology and for instructors hoping to teach it. If there was an overarching theme that emerged from the discussions, it might be the idea of giving students access to scientific practice, which might mean giving students opportunities to access particular techniques or modes of reasoning, and might also mean giving students more flexibility in terms of time and space so that they can take part in lab activities at all.

As our 'strengths list' (Table 1) suggests, it is probably the case that certain aspects of biological practice are most readily accessed in certain environments. A lab curriculum consisting of a series of weekly two-hour experiments might give students particularly good access to the dimensions of scientific practice related to experimental design and the ambiguity and troubleshooting characteristics of experimental work, the use of equipment to make observations, and synchronous group work, but might also struggle to capture the important features relating to long-term observations, large datasets, and perhaps the use of software in data analysis – elements of scientific work that an online lab might be able to emphasize with relative ease. As a result, we advise against the temptation to assume that on-campus labs are for biology majors and online labs are for non-majors.

It is possible to design a lab either thoughtfully or without care for either environment, but we suggest that the development of an online lab is particularly risky when the design process is understood as 'porting' on-campus labs over to a new environment, without careful consideration being given to how the online environment can best capture the aspects of scientific practice that we consider important for our students. In this workshop, participants instead approached lab design as an intentional and iterative process, taking seriously the potential differences between on-campus and online spaces for meaningful learning about practicing science.

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Appendix A
Workshop Participant Handout

This handout was circulated to participants after the Introduction and Whole-Group Discussion portion of the workshop. The revised version included here has been edited for readability and to update URLs. It also includes updates to the 'Resources' section and a summary of the Whole Group Discussion, which were e-mailed to participants immediately after the conference. Sample converted labs, originally included in the handout, have been moved to Appendix C.

Conversion Immersion: Adapting Labs for Online or On-Campus Use

ABLE 2014 Major Workshop

1. Workshop Outline

Allocated Time	Activity	
45 minutes	**Workshop Introduction and Whole-Group Discussion** • presenter introductions • Why do labs? (group discussion – think/share) • Why do labs online? (group discussion - share) • conversion stories • strengths of each learning environment • organize Group Set 1	
45 minutes	**Small-Group Set 1**: participants with similar lab topics • **Goal for this session**: Each participant should convert one "keeper" aspect of his/her lab for use in the alternate environment. Guiding questions and ideas are included on the worksheet. • **Small-Group Set 1 quick reports**: A few volunteers report back to the whole group on their decisions about converting the "keeper" aspect for the new domain. • **Submit worksheets to the presenters** – they'll be copied and returned!	*GG and JVD circulate among groups, listen to discussions, take notes*
30 minutes	**Break**	
45 minutes	**Small-Group Set 2**: participants with different lab topics • **Goal for this session**: Each participant should tackle one domain-specific challenge to converting the lab. Guiding questions and ideas are included on the worksheet.	*GG and JVD circulate among groups, listen to discussions, take notes*

	• **Group Set 2 quick reports**: A few volunteers report to the whole group on their discussions and decisions about the likely challenges in converting their labs. • **Submit worksheets to the presenters** – they'll be copied and returned!
15 minutes	summary observations; group discussion of issues arising

2. Strengths of Each Learning Environment

On Campus	Online
physical manipulation of specimens and equipment	long-term data and more complex studies
richer sensory experience	web-based/software tools for certain aspects of biological practice
immediacy and complexity of environments and phenomena	access to phenomena, techniques, places of scientific work
social interactions • group work (e.g. in designing experiments) • real-time feedback from TA / instructor / peers	social interactions • peer review • asynchronous discussion • potentially larger and more diverse group
diversity of interactions with the environment	independent work
unpredictable or open-ended activities	continuity of experience
routine (mundane?) lab skills and troubleshooting	do-overs

3. Resources

3.1 The Online Learning Consortium (formerly the Sloan Consortium)
http://onlinelearningconsortium.org/

The Online Learning Consortium (OLC) offers a wealth of resources and professional development opportunities in online teaching ranging from hour-long webinars and half-day workshops to longer workshop series and certificate programs, including the Online Science Labs Mastery Series[1]. Jennifer has completed both the Online Teaching Certificate Program and the Online Science Mastery Series, and would be happy to discuss her experiences with anyone who's interested in the OLC.

3.2 Finding Online Lab Resources in Your Discipline
(adapted with permission from the OLC Online Science Labs Mastery Series, with additions by the authors)
3.2.1 General Searching
Google Scholar
http://scholar.google.com

Access any online database available to your institution. Use keywords such as 'science', 'online lab', your discipline, etc. You can also Google scholar if you do not have access to literature search databases.

Multimedia Educational Resource for Learning and Online Teaching (MERLOT)
http://www.merlot.org/merlot/index.htm
This site houses a collection of peer reviewed learning objects, many of which are related to science and/or science labs. Target your discipline or particular topic of interest on the learning materials search screen.

National Science Digital Library
http://nsdl.org/
This site has links to many online educational resources for teaching and learning, with an emphasis on the sciences, technology, engineering, and mathematics (STEM) disciplines.

Online Learning Consortium Effective Practices Awards
http://onlinelearningconsortium.org/about/olc-awards/effective-practices/ (Scroll down to 'View the Effective Practices'.)

1 http://onlinelearningconsortium.org/masteryseries/online-science-labs-mastery-series/

3.2.2 Project-Specific Websites

GO-LAB (Global Online Science Labs for Inquiry Learning at School)
http://www.go-lab-project.eu/project

European collaborative project co-funded by the European Commission uniting multiple countries. The project goal is to provide access to online laboratories for enriched classroom experiences in schools and outside class.

iLab
https://wikis.mit.edu/confluence/display/ILAB2/Home

A partnership to provide remote access to labs for engineering and science.

The Iowa Virtual Slidebox
http://www.mbfbioscience.com/iowavirtualslidebox

An open access collection of whole slide images for teaching histology and histopathology.

Jorum
http://www.jorum.ac.uk/

Jorum was created by the UK Further and Higher Education community, with a goal to collect and share learning and teaching materials.

Molecular Workbench
http://mw.concord.org/modeler/

Free and open-source modeling tool developed for designing and conducting visual and interactive experimental simulations across science disciplines. Developed by the Concord Consortium and funded by the NSF.

NANSLO
http://www.wiche.edu/nanslo

Remote web-based labs for physics, biology, and chemistry, including access to remotely-controlled microscopes.

OpenScience Laboratory
https://learn5.open.ac.uk/course/view.php?id=2&page=3

An initiative of the Open University and The Wolfson Foundation which includes simulations, remote experiments and virtual scenarios using real data.

PBS LearningMedia
http://www.pbslearningmedia.org/

Access a list of PBS educational media including some interactive simulations which could be the basis of lab exercises. Primarily K-12 but some target college and university level.

Value@Amrita Project
http://amrita.vlab.co.in/index.php

This is the site for a virtual lab project at Amrita University covering many disciplines. The project is an initiative of India's Ministry of Human Resource Department. Users must register to access the labs.

Virtual Labs
http://vlab.co.in/

An Initiative of India's Ministry of Human Resource Development (MHRD) Under the National Mission on Education through ICT.

UniSchool project
http://unischoolabs.eun.org/web/guest

Promoting collaboration for European high schools to access remote or virtual labs at universities.

University of Delaware Virtual Compound Microscope
http://www.udel.edu/biology/ketcham/microscope/scope.html

Flash-based virtual microscope that is manipulated by the user; includes a set of four slides (bacterial cells, onion cells, epithelial cells, and the letter 'e'). Co-developed by ABLE member Bob Ketcham.

3.2.3 Example Projects from Specific Disciplines

Annenberg Learner
http://www.learner.org/

Organization devoted to professional development and distribution of multimedia resources for teaching and learning including a searchable database of 'interactives'; some designed as labs.

Howard Hughes Medical Institute Virtual Labs
http://www.hhmi.org/biointeractive/vlabs/

Virtual labs suitable for biology or medical fields. A major workshop on the HHMI Stickleback Evolution Virtual Lab was presented at the 2013 ABLE meeting at the University of Calgary[5]

Population Biology Simulations
http://darwin.eeb.uconn.edu/simulations/simulations.html

Set of simulations for teaching principles of population genetics and population ecology; created by Kent Holsinger at the University of Connecticut.

Population/Community Biology: Community Sampling Exercise
http://www.departments.bucknell.edu/biology/courses/biol208/EcoSampler/

Digitized forest sites to for use in investigating sampling theory and methods.

Populus
http://www.cbs.umn.edu/populus/

Interactive simulations for teaching biology and evolutionary ecology from the University of Minnesota.

University of Utah Genetic Science Learning Centre
http://learn.genetics.utah.edu/

This site hosts a number of animations and learning activities as well as a set of virtual labs in genetics.

The Virtual Autopsy
http://www.le.ac.uk/pa/teach/va/titlpag1.html
A site originally created by two students, hosted at the University of Leicester. It has a number of cases where cadavers and samples can be examined to determine cause of death.

3.2.4 Commercial Remote and/or Online Lab Providers

Smart Science http://www.smartscience.net/SmartScience/SmartScience.html	blended labs
eScience Labs http://www.esciencelabs.com/	lab kits
Hands-On Learning https://holscience.com/	lab kits
Kemtec http://www.kemtecscience.com/	lab kits
Quality Science Labs, LLC http://www.qualitysciencelabs.com/	lab kits

[5]Park, P. J., L. Bonetta, D. Liu, A. Brokaw, and M. A. Bell. 2014. Practical Applications of the HHMI Stickleback Evolution Virtual Lab. Pages 270-280 in Tested Studies for Laboratory Teaching, Volume 35 (K. McMahon, Editor). Proceedings of the 35th Conference of the Association for Biology Laboratory Education (ABLE), 477 pages. http://www.ableweb.org/volumes/vol-35/v35reprint.php?ch=16

Classical Genetics Simulator[6]
http://cgslab.com/ virtual labs

Late Nite Labs
https://latenitelabs.com virtual labs

SimBio
http://simbio.com/ virtual labs

4. Readings

de Jong,T, Linn, MC, Zacharia, ZC. 2013. Physical and virtual laboratories in science and engineering education. Science 340 (6130): 305-308 doi:10.1126/science.1230579.

This recent article compares examples of traditional and virtual labs and talks about how they can be combined to strengthen the learning experience. The authors also stress the importance of proper design to ensure valid learning.

Friesen, N. 2011. The Place of the Classroom and the Space of the Screen. New York: Peter Lang.

Putting aside what he sees as the settled question of whether online and offline learning are both effective, in this interesting study Friesen instead considers the nature of experience for students and teachers working within these two different settings from each session that were noted on the chalkboard are presented below.

5. Whole Group Discussion Summary

During the 'whole group discussion' portion of the workshop we discussed why we do labs at all, and why we might do them online. The (mostly unedited) contributions from each session that were noted on the chalkboard are presented below.

5.1 What is lab for?

Morning Session (21 participants)	Afternoon Session (8 participants)
learning to observe	hands-on /real world
collecting / analyzing data	making sense of / adding detail to biological concepts
to make mistakes / have things not work	excitement and relevance • to own lives • of scientific method
deeper understanding of biology content	social facilitation and collaboration
hands-on experience with equipment	exploration, curiosity, new experiences
remove fear of working in a scientific environment	experience of scientific practice / work → "testing the waters"
to do science instead of hearing result	different view of unpredictability / variability
to do better in group work	experience in techniques
base conclusions on evidence	
learn experimental design and role of controls	
encourage critical thinking and inquiry	
execute written/verbal directions	
communication skills (written/verbal)	
different source of assessment than lecture	
expose and address misconceptions	
get students excited about science	
[students can] decide if they want to / can do science	
get ready for future work	

[6]search 'Classical Genetics Simulator' in ABLE's Tested Studies for Laboratory Teaching for CGS workshops

5.2 Why do labs online?

Morning Session (21 participants)	**Afternoon Session** (8 participants)
flexibility in scheduling / efficient use of lab rooms	hybrid classes
studies using [expensive] equipment, long-term, too dangerous	practice / pre-lab / supplemental / getting up to speed
access • without coming to campus • for students with disabilities	scientific work at home (home labs) → safety
self-pacing / student-centred	reduce supply costs
larger class sizes, beyond physical space and staffing	access to scientific work • distance • life circumstances • students with disabilities
enrichment / excitement	relevance to modern scientific tools / practice
element of blended course	long-term / dangerous
save money (?)	scheduling flexibility
labs don't get cancelled	make-up labs
make-up labs	practical alternative to traditional labs
experience with new techniques	
repeating class	

Appendix B
Group Discussion Worksheets

Guiding questions for the group discussion portions of the workshop; the versions circulated to participants (Whole-Group Discussion and Small-Group Set 1 Guiding Questions on one worksheet, Small-Group Set 2 Guiding Questions on another) included space after each set of questions to record notes. These sheets were photocopied and returned to participants before the end of the workshop.

Conversion Immersion: Adapting Labs for Online or On-Campus Use
ABLE 2014 Major Worksho

Whole-Group Discussion
What is lab for? Why do we have labs? What should happen in the lab component of a class?
What should students be learning in labs?

Why offer labs online?

Small-Group Set 1 Guiding Questions

Looking back to the "what is lab for?" list, which elements will you choose to do really well in the lab that you've chosen to convert?

What particular element that you want to retain in the converted lab will you work on today? What can you leave behind? What is this lab really about, or what could it be about?

How will you handle logistical elements such as presenting instructions and data as well as submission of student work?

Small-Group Set 2 Guiding Questions

What aspect of this lab will be the most challenging to include in the new environment? How could you deal with this challenge?

What are you worried about losing or not being able to do? What do you think you will gain or be able to do better?

Any additions or changes to suggest for the 'strengths' list?

Appendix C
Sample Labs Converted Between Online and On-Campus Delivery

Copies of the online versions[1] of our sample labs are located outside of our institution's learning management system) Blackboard Learn 9.1), for the purposes of this workshop and manuscript. Accompanying documents that students would normally download from another location within the learning management system, as well as the on-campus versions of the labs (where applicable), are included in this appendix.

Phylogenetics, Systematics, and Bioinformatics

Students use morphological and sequence data from different groups of fish to explore the evolutionary relationships among the groups. The online version includes some background information about the fish, presented in the form of a video. This differs from the pre-lab material that is provided to students in the on-campus version, which includes a citation and paraphrasing activity that is part of an ongoing theme in the on-campus lab series. Students work independently in the online version of the lab, while students on campus collaborate with their peers and use props to generate their morphological and sequence data. In both versions of the lab, students use the same web-based bioinformatics tools and answer similar questions about the data.

link to online version: http://tinyurl.com/bioinformaticsintro

student documents to accompany online version:
- BIOL1020_surname_bioinformatics_F13.rtf
- pairwisealignment.pdf
- ClustalInstructions.pdf
- FishSequences.txt

on-campus version: Lab 7, Using Molecular Biology to Study Evolution

Mendelian Genetics

A classic Mendelian genetics lab that uses corn cobs to test hypotheses about inheritance. In the on-campus version of the lab, students work with real corn cobs to collect their data; in the online version, students use ImageJ to work with photos of the corn cobs.

link to online version: http://tinyurl.com/mendeliangenetics

student documents to accompany online version:
- BIOL1020_surname_mendeliangenetics_F13.rtf
- statisticsinintroductorybiology.pdf

on-campus version: Lab 5, Mendelian Genetics

Pancreatic Enzymes and Diseases

This lab was developed by Gill for the online class specifically; there is no face-to-face counterpart. It is included as an example of a 'conversion' that assembles concepts from the on-campus labs and incorporates them into an exercise that works well with online delivery: drawing on novel information from scientific literature, students design an experiment to investigate the action of pancreatic enzymes. Then with feedback from their TA, they revise and build upon their original design.

link to lab: http://tinyurl.com/PEDcombined

student documents to accompany lab:
- BIOL1021_surname_pancreaticenzymesI_F13.rtf
- Controlled Experiments S13.pdf
- Pancreatic enzymes and diseases readings.pdf
- BIOL1021_surname_pancreaticenzymesII_F13.rtf

1 Authored in SoftChalk (http://softchalk.com), a versatile and user-friendly commercial program that requires little to no prior knowledge of HTML and allows the user to build interactive online content.

BIOL1020_surname_bioinformatics_F13.rtf
BIOL 1020
Lab Assignment: Phylogenetics, Systematics, and Bioinformatics

Start by re-saving this file as follows: **lab_surname_bioinformatics.rtf**, substituting your own surname. **Remember to convert to PDF** after you have finished entering your answers and before submitting for grading.

Type your responses to the questions below where indicated. Remember to save your work frequently.

Meet the Flatfish
1. Watch the video called "Meet the Flatfish", and as you watch, fill out Table 1 below using the taxonomic information about the four fish species presented in the video. (4 marks)

Table 1. Taxonomic information for four fish species.

common name	order	family	genus	species
starry flounder				
turbot				
Atlantic halibut				
Senegalese sole				

2. Recall that a phylogenetic tree is a hypothesis about relatedness. According to the phylogenetic tree in Figure 2, which two species are the most closely related? (2 marks)

RESPONSE:

PLEASE LEAVE THE SPACE BELOW EMPTY FOR TA COMMENTS

3. Review the images of the five fish species in Figure 3, and describe TWO morphological features shared by all of the Pleuronectiformes that are not seen in the Salmoniformes. (Be specific in your answer, contrasting the features seen in the Pleuronectiformes with those seen in the Salmoniformes.) (3 marks)

RESPONSE:

PLEASE LEAVE THE SPACE BELOW EMPTY FOR TA COMMENTS

From Morphology to Molecules

4. IF the relationships hypothesized in Figure 3 are correct, AND a 23 bp DNA sequence is collected from each of the four fish species and its nucleotide sequence examined, THEN you predict that you will observe the greatest sequence similarities in which pair of fish species? (1 mark)

RESPONSE:

PLEASE LEAVE THE SPACE BELOW EMPTY FOR TA COMMENTS

Pairwise Alignment of DNA Sequences

In this section of the assignment, you will align and compare short example DNA sequences from the four flatfish species, then calculate pairwise alignment scores to determine the degree of similarity between each pair of sequences, in order to test the hypothesis about the relatedness of the fish species represented in Figure 2.

The DNA sequences for each fish species are placed in individual text boxes, so that you can move the boxes around to more easily compare each pair of sequences. (Hint: Click on the border of a box and then use your Ctrl + arrow keys to 'nudge' it around the page.)

Choose a pair of fish to compare, and then move their text boxes so that the base-pair letters are aligned. Then, count the number of differences between the two sequences. Subtract the number of differences from the total number of bases (letters) in the sequence (hint: see the caption to Table 2), then divide that value by the total number of bases. Multiply your answer by 100 and you will have calculated the pairwise alignment score for that pair of fish species.

turbot: 5' - ATTACGAACAACCATCTAGCTTG - 3'

flounder: 5' - ATTACGATCTAGGATCTAGCTTG - 3'
halibut: 5' - ATTACGATGTAGGATCTAGCTTG - 3'

sole: 5' - ATTACGAACAAAGATCTAGCTTG - 3'

5. Aligning, comparing, and calculating alignment scores for every possible pairing of fish species could take awhile, so you don't have to do every possible alignment yourself; instead, perform a sequence alignment and calculate a pairwise alignment score for three pairings of fish, including the pair that your hypothesis predicts will be the most similar. Enter your results in Table 2 below. (Feel free to do more pairwise comparisons if you wish – three pairings is the minimum required.) (6 marks)

Table 2. Pairwise alignment scores for three pairs of fish, based on comparison of 23-bp example DNA sequences.

pair of fish species compared	pairwise alignment score

6. Are the results of your pairwise alignment study of DNA sequences consistent with your prediction? Should you reject the hypothesis, or not? (2 marks)

RESPONSE:

PLEASE LEAVE THE SPACE BELOW EMPTY FOR TA COMMENTS

Bioinformatics Tools and Molecular Systematics

7. In the space below, insert the cladogram generated by ClustalW2 based on COX1 DNA sequences for four fish species. (2 marks)

INSERT CLADOGRAM:

PLEASE LEAVE THE SPACE BELOW EMPTY FOR TA COMMENTS

8. Compare the cladogram generated by ClustalW2 using molecular data to the phylogenetic tree based on morphological data (Figure 2) that you analysed earlier in this assignment. (You will notice that the fish species are indicated by identification codes on the ClustalW phylogenetic tree; you'll need to refer to the table in the Clustal instructions document to remind yourself which code corresponds to each species. You'll also notice that the trees are turned 90 degrees relative to one another – that is not a meaningful difference between the trees.) What are some significant similarities or differences between the two trees? (2 marks)

RESPONSE:

PLEASE LEAVE THE SPACE BELOW EMPTY FOR TA COMMENTS

9. In a closely-related group such as fish, COX1 gene (nucleotide) sequences often give more information about relatedness than COX1 protein (amino acid) sequences (Ward and Holmes, 2007). Why might this be? (Hint: think about codons!) (2 marks)

RESPONSE:

PLEASE LEAVE THE SPACE BELOW EMPTY FOR TA COMMENTS

References

Ward RD, Holmes BH. 2007. An analysis of nucleotide and amino acid variability in the barcode region of cytochrome c oxi-

dase I (cox1) in fishes. Molecular Ecology Notes. 7: 899-907.
Pairwisealignment.pdf

Pairwise Alignment of DNA Sequences

Use this for reference if you are unable to view the 23-bp sequences in the rtf assignment document (immediately preceding Question 5). You won't be able to 'move the boxes around' as instructed below, but you can duplicate them on scrap paper or even print this sheet and cut them out to align them.

In this section of the assignment, you will align and compare short example DNA sequences from the four flatfish species, then calculate pairwise alignment scores to determine the degree of similarity between each pair of sequences, in order to test the hypothesis about the relatedness of the fish species represented in Figure 2.

The DNA sequences for each fish species are placed in individual text boxes, so that you can move the boxes around to more easily compare each pair of sequences. (Hint: Click on the border of a box and then use your Ctrl + arrow keys to 'nudge' it around the page.)

Choose a pair of fish to compare, and then move their text boxes so that the base-pair letters are aligned. Then, count the number of differences between the two sequences. Subtract the number of differences from the total number of bases (letters) in the sequence (hint: see the caption to Table 2), then divide that value by the total number of bases. Multiply your answer by 100 and you will have calculated the pairwise alignment score for that pair of fish species.

turbot: 5′ - ATTACGAACAACCATCTAGCTTG - 3′

flounder: 5′ - ATTACGATCTAGGATCTAGCTTG - 3′

halibut: 5′ - ATTACGATGTAGGATCTAGCTTG - 3′

sole: 5′ - ATTACGAACAAAGATCTAGCTTG - 3′

BIOL 1020 Lab Assignment: Phylogenetics, Systematics, and Bioinformatics 1

ClustalInstructions.pdf

Performing a multiple sequence alignment using Clustal Omega:

Please read through all of the steps below before beginning to work with Clustal Omega.

i. "FishSequences.txt" is a text file containing a full set of COX1 gene sequences in FASTA format for the four fish species. Each sequence is represented by a number; in the table below, you can see which number corresponds to each fish.

Common name	COX1 DNA sequence identification code (NCBI Gene database)
Atlantic halibut	gi|154000803:5604-7060
starry flounder	gi|190349412:5601-7060
Senegalese sole	gi|114052818:6488-8039
turbot	gi|258985322:5601-7151

ii. You can provide this information to a tool called Clustal Omega which will perform a sequence alignment for you. Recall the earlier stage of this assignment, when you compared short sequences manually – you may have found the process tedious and prone to mistakes. Now imagine trying to manually align sequences like the COX1 gene that are 1500 bp in length! Tools like Clustal Omega automate the process. Clustal is a web-based application; to start using it, go to http://www.ebi.ac.uk/Tools/msa/clustalo/

iii. Clustal Omega uses Java to generate the results tables and graphics, so before you begin, make sure that your Java plugin is up to date (go to www.java.com, and click Download – the page will automatically check your computer to make sure you have the latest version.

iv. Under "Step 1: Enter your Input sequences", first make sure that DNA is selected from the drop-down menu, then click the Browse button, and use the window that opens to locate the "FishSequences.txt" file on your computer. Click **Open** to upload that file to Clustal Omega. If you had highlighted the text rather than downloading the file, then instead of clicking Browse, paste (Ctrl-V on a PC or Command-V on a Mac) the sequence text into the box.

v. You can ignore steps 2 and 3 on the Clustal Omega page, as we will be using the default settings.

vi. Click the **Submit** button to have Clustal Omega perform the sequence alignment. You are using four sequences of about 1500 base-pairs each, so allow some time for the alignment to be computed.

vii. The results will likely appear after 30 seconds or so. Click the **Results Summary** tab, then click **Start Jalview** to see a colour-coded representation of the aligned sequences, and a consensus sequence listed at the bottom of the screen. When you are done exploring, make a note of any questions that have occurred to you, and then return to the **Alignments** tab and **Download Alignment File** to save a copy of the multiple sequence alignment somewhere on your computer (make a note of the file's name and location) to use in the next step: generating a phylogenetic tree.

FishSequences.txt

>gi|114052818:6488-8038 Solea senegalensis mitochondrion, complete genome
GTGACAATTACACGTTGATTTTTCTCGACCAACCACAAAGACATCGGTACCCTCTATCTTGTATTTGGTG
CCTGAGCTGGAATAGTGGGCACAGCCCTAAGCCTGCTAATTCGAGCTGAACTAAGCCAACCCGGCTCCCT
TCTCGGAGACGATCAAATCTACAATGTTATCGTTACCGCCCATGCCTTCGTAATAATTTTCTTTATAGTA
ATACCAGTAATAATTGGAGGCTTCGGAAACTGACTAATCCCCCTAATGATTGGAGCCCCAGACATAGCAT
TCCCCCGAATAAACAACATGAGCTTCTGACTCCTTCCACCTGCTTTCCTCCTGCTTCTTACTTCATCCGT
TGTGGAGGCTGGGGCTGGGACAGGATGAACTGTCTACCCCCCTCTTTCAAGCAACCTCGCCCATGCAGGT
GCATCCGTAGACCTAACAATTTTTTCTCTACACCTGGCCGGAGTATCATCCATTCTTGGAGCAATTAACT
TTATCACAACCATCATTAATATGAAACCTGCCACTATAACGATATATCAAATGCCCCTATTTGTCTGATC
CGTACTAATTACTGCTGTACTTCTCCTTCTATCCCTCCCAGTCTTAGCTGCAGGAATTACGATACTTCTA
ACCGACCGAAACCTAAACACAACCTTCTTTGACCCTGCTGGAGGAGGAGACCCCGTCCTCTATCAACACC
TATTCTGATTCTTTGGCCACCCAGAAGTTTACATTCTTATCCTCCCAGGTTTCGGAATGATCTCCCATAT
CATCGCATTCTACTGTGGGAAAAAAGAACCATTCGGTTATATGGGCATGGTCTGAGCAATAATGGCAATT
GGCCTACTAGGGTTTATTGTCTGAGCACATCACATATTTACAGTCGGGATGGACGTCGACATTCGAGCAT
ACTTTACATCCGCTACAATAATTATTGCTATCCCCACAGGTGTTAAAGTGTTTAGCTGACTAGCCACACT
ACACGGAGGAAAAATTACCTGGGACACCCCCTTCCTCTGAGCCCTAGGTTTCATCTTCCTCTTCACTGTC
GGGGGCCTAACCGGAATTGTCCTATCCAATTCTTCTCTAGACATCATCCTCCATGACACATACTATGTAG
TAGCACATTTCCACTACGTCCTCTCCATGGGAGCTGTCTTTGCAATTATGGCAGGCTTCGTTCACTGATT
CCCGCTACTTTCAGGCTACACACTCCACTCCACATGAACTAAAGTTCACTTTGGAGTAATGTTTGTAGGA
GTAAACCTAACATTCTTCCCCCAACACTTCCTAGGACTGGCCGGAATGCCCCGACGATACTCTGACTATC
CAGATGCCTACACCTTATGAAACACTGTCTCATCTATTGGATCAATAATTTCCCTCATCGCCGTAATTAT
GTTTTTATTTATCTTATGGGAAGCCTTCACGGCAAAACGAGAAGTTCTCATGGTAAAATACGCTCAACTA
AACGTCGAATGACTCCACGGTTGCCCTCCACCAAACCACACATTCGAGGAACCTGCCTTTGTCCAAGTTC
GCCACAACTAA

>gi|256985322:5601-7151 Psetta maxima mitochondrion, complete genome
GTGACCTTTATACGCTGGTTTATATCTACCAACCACAAAGATATCGGGACTTTATATCTTATCTTCGGGG
CCTGGGCCGGAATAGTAGGTACAGCCCTCAGCTTACTAATTCGTGCTGAACTCAGCCAGCCAGGAGCCCT
CCTAGGTGATGATCAGATTTACAATGTTATCGTCACGGCCCATGCTTTCGTAATGATTTTCTTCATGGTA
ATACCTATTATGATCGGAGGTTTTGGTAACTGACTTATTCCTCTTATGCTGGGCGCCCCTGATATAGCAT
TCCCTCGAATAAACAACATGAGCTTTTGACTTCTGCCCCCTTCATTTCTCCTCCTTTTGGCCTCCTCAGG
CGTAGAAGCCGGAGCAGGAACTGGGTGAACTGTATATCCCCCCTTATCTGGAAACCTAGCGCATGCAGGA
GCATCCGTAGACCTGACCATCTTTTCTTTACATCTGGCAGGAATTTCCTCTATTTTAGGTGCTATTAATT
TTATTACCACTATTATTAACATGAAACCTACAACTGTTTCCATGTACCAAATTCCCCTGTTCGTATGAGC
CGTCCTAATTACAGCCGTTCTCCTTCTGCTATCTCTCCCAGTTTTAGCTGCTGGCATTACAATGCTACTT
ACAGATCGTAACCTCAACACCGCTTTCTTTGACCCCGCGGGGGGAGGAGACCCGATTTTATACCAACACT
TGTTCTGGTTCTTCGGACACCCAGAAGTATATATTCTTATTCTTCCCGGCTTTGGAATAATCTCCCATAT
CGTCGCTTACTACGCTGGTAAGAAAGAACCCTTCGGCTATATGGGAATAGTGTGAGCGATAATAGCTATT
GGCCTGCTCGGGTTTATTGTCTGAGCACATCATATGTTTACAGTAGGTATAGACGTGGACACTCGCGCTT
ACTTCACCTCCGCTACAATGATTATTGCAATCCCGACGGGTGTAAAAGTCTTCAGTTGGCTCGCAACACT
CCATGGAGGTAATATTAAGTGAGAAACACCACTCCTCTGAGCCTTAGGCTTCATCTTCCTATTTACAGTA
GGAGGTTTAACCGGTATTATTCTAGCCAACTCCTCCTTAGATATTGTCCTCCATGACACATATTATGTTG
TAGCCCATTTCCATTATGTCTTATCCATAGGGGCAGTCTTTGCAATTGTTGCTGCTTTCGTTCACTGGTT
CCCCCTGTTTACAGGTTATACCCTTCACACCGCATGAACTAAAGTCCATTTCGGAGTAATATTCCTCGGA
GTTAATTTAACTTTCTTTCCCCAGCATTTCCTTGGTCTAGCAGGAATACCTCGCCGATATTCGGACTACC
CAGATGCCTACACACTATGAAATACAGTATCCTCAATTGGATCTCTAATTTCCCTCCTAGCTGTAATTAT
ATTCTTATTTATTTTATGGGAAGCATTTGCCGCTAAGCGAGAAGTACTCTCAGTAGAACTAACCGCTACA
AATGTTGAGTGACTACACGGCTGCCCTCCTCCCTATCACACATTTGAAGAACCTGCTTTCGTACAGGCCC
CCTCAAACTAA

>gi|154090893:5504-7069 Hippoglossus hippoglossus mitochondrion, complete genome
GTGGCAATCACACGTTGATTTTTCTCGACCAATCACAAAGACATCGGCACCCTCTATCTCGTATTTGGTG
CCTGAGCCGGAATAGTGGGGACAGGCCTAAGTCTGCTTATTCGGGCAGAACTAAGCCAACCCGGGGCTCT
CCTGGGAGACGACCAAATTTATAATGTGATCGTCACCGCACACGCCTTTGTAATAATCTTTTTTATAGTA
ATACCCATTATGATTGGGGGGTTCGGAAACTGGCTTATTCCACTAATAATTGGGGCCCCAGACATGGCGT
TCCCTCGAATGAATAATATGAGTTTCTGACTTCTTCCCCCCTCCTTTCTCCTCCTCTTAGCCTCTTCAGG
TGTTGAAGCCGGAGCAGGTACCGGATGAACCGTGTACCCCCCACTAGCTGGCAATTTAGCCCACGCCGGG
GCATCCGTAGACCTGACAATCTTCTCACTTCACCTTGCAGGAATTTCATCAATTCTGGGGGCAATTAACT
TTATTACTACCATCATTAACATGAAACCCACAACAGTCACTATGTACCAAATCCCGTTATTTGTTTGAGC
CGTTCTTATTACAGCCGTACTTCTTCTTCTGTCCCTGCCCGTTTTAGCCGCAGGGATTACAATGCTACTA
ACAGACCGCAACCTTAACACGACCTTCTTTGACCCTGCCGGAGGAGGTGACCCCATTCTCTACCAACACC
TATTCTGATTCTTTGGCCACCCAGAGGTATACATTCTTATCCTCCCAGGCTTCGGAATAATTTCTCACAT
TGTTGCATACTATGCAGGTAAGAAAGAACCTTTTGGCTACATGGGGATAGTCTGAGCTATAATGGCCATT
GGACTCCTGGGCTTCATTGTCTGGGCCCATCACATATTTACAGTCGGAATAGACGTAGATACACGAGCCT
ACTTTACCTCTGCCACAATAATCATTGCGATTCCAACTGGCGTAAAAGTCTTTAGCTGACTCGCAACCCT
CCATGGGGGAAGCATTAAATGAGAAACGCCCCTTCTATGAGCCCTCGGCTTTATTTTCCTCTTTACAGTA
GGCGGTCTCACTGGCATTGTCTTAGCTAACTCCTCTCTCGATATTGTTCTGCATGACACATACTATGTAG
TCGCCCACTTCCACTATGTACTATCTATGGGTGCTGTATTTGCAATCGTTGCCGCCTTCGTCCATTGATT
TCCGTTATTTACAGGCTATACCCTTCACTCCACATGAACAAAAATCCACTTCGGCCTGATGTTTATTGGG
GTCAATCTAACATTCTTCCCTCAACATTTTCTGGGCCTGGCTGGGATACCCCGACGGTACTCAGACTACC
CAGACGCATACACCCTTTGAAACACTGTTTCATCAATTGGGTCCCTAATGTCCCTCGTTGCTGTAATTTT
ATTCTTATTCATTATTTGAGAAGCATTTACAGCCAAACGAGAAGTCGGAGCAGTAGAACTAACTGCAACT
AACATTGAATGACTTTACGGCTGCCCTCCCCCCTACCACACATTTGAAGAGCCCGCATTCGTACAAGTTC
GTATAAATTCGAACAAACTAACGAGA

>gi|190349412:5501-7060 Platichthys stellatus mitochondrion, complete genome
GTGGCAATCACACGTTGATTTTTCTCGACCAATCACAAAGACATCGGCACCCTCTATCTCGTATTTGGTG
CCTGAGCCGGAATAGTGGGGACAGGCCTAAGTCTACTCATTCGAGCAGAGCTAAGCCAACCTGGGGCTCT
CCTGGGGGACGACCAAATTTATAACGTAATCGTCACCGCACACGCCTTTGTAATAATTTTCTTTATAGTA
ATACCAATTATGATTGGAGGGTTTGGAAACTGACTTATCCCATTAATAATTGGGGCCCCCGATATGGCCT
TCCCTCGAATAAATAACATGAGCTTCTGACTCCTACCCCCATCCTTCCTGCTTCTCCTGGCCTCTTCAGG
TGTTGAAGCCGGGGCGGGAACAGGGTGAACTGTATATCCCCCACTAGCTGGAAACCTAGCACACGCCGGG
GCATCCGTAGACCTCACAATCTTTTCCCTTCACCTTGCCGGAATTTCATCAATTCTAGGGGCAATCAACT
TTATTACCACCATTATCAACATGAAACCAACAGCAGTCACTATGTACCAAATCCCACTGTTTGTTTGGGC
CGTACTAATTACCGCCGTTCTTCTTCTCCTTTCCCTTCCGGTCTTAGCCGCTGGCATTACAATGCTACTA
ACAGACCGCAACCTGAACACAACCTTCTTTGATCCTGCTGGAGGAGGTGACCCCATCCTCTACCAGCACC
TGTTCTGATTCTTTGGCCACCCAGAGGTATACATTTTAATTCTTCCAGGCTTCGGGATAATTTCTCACAT
TGTTGCATACTATGCAGGTAAGAAAGAACCCTTTGGCTACATGGGCATGGTCTGAGCTATGATGGCTATT
GGACTCCTGGGCTTCATCGTATGGGCCCATCACATGTTTACAGTCGGAATAGACGTAGACACACGAGCTT
ACTTTACCTCAGCCACAATAATTATTGCCATCCCAACCGGCGTAAAAGTCTTTAGCTGACTCGCAACCCT
CCACGGGGGAAGCATTAAATGAGAAACCCCACTTCTATGAGCTCTAGGCTTTATTTTCCTATTTACAGTC
GGAGGTCTTACTGGTATTGTCTTAGCTAACTCGTCTCTTGATATTGTACTTCATGACACATACTATGTAG
TAGCCCACTTCCACTATGTCCTATCAATAGGAGCTGTATTTGCAATCGTTGCCGCCTTTGTGCACTGATT
CCCCCTATTTACAGGCTACACCCTCCACTCTACATGAACAAAAGTCCACTTTGGCCTAATGTTTGTCGGA
GTCAATTTAACATTCTTCCCCCAACACTTCCTCGGTCTAGCAGGAATACCTCGACGGTACTCAGACTACC
CCGATGCATACACGCTTTGAAATACTGTCTCATCAATCGGGTCGCTAATGTCGCTCGTTGCTGTTATCTT
ATTTTTATTTATTATTTGAGAAGCATTTACTGCCAAACGAGAAGTCGGGGCAGTAGAACTAACTTCAACT
AATATTGAATGACTTTACGGCTGCCCTCCACCCTACCACACATTTGAAGAGCCCGCATTCGTTCAAGTTC
GTATAAATTCGAACGGCTAA

Lab 7: Using Molecular Biology to Study Evolution

Lab 7
Using Molecular Biology to Study Evolution

Name:

Lab day:

Lab time:

Lab room:

TA:

LEARNING OBJECTIVES

By the end of this lab, you should be able to:

1. Use a phylogenetic tree as a hypothesis to generate a prediction.
2. Align and compare short example DNA sequences and calculate pairwise alignment scores for each pair, in order to test the hypothesis.
3. Use an online bioinformatics resource to perform a multiple sequence alignment and comparison and to construct a phylogenetic tree.
4. Identify similarities and meaningful differences between two phylogenetic trees.
5. Properly paraphrase a passage from a published source and provide an in-text citation.

PRE-LAB EXERCISES

Complete the prelab quiz between 8am Thurs – 8am Monday before your scheduled lab time.

Note: You will be required to bring a laptop computer or tablet to lab this week if you have one. Additionally, you will need to install or update a program called Java on your computer in order to use the internet based analysis tool in this week's lab. Before coming to lab, visit the website www.java.com to update your computer.

In Chapter 26 of your textbook, read the Overview, Concept 26.1, "Phylogenies show evolutionary relationships", and Concept 26.2, "Phylogenies are inferred from morphological and molecular data".

BIOL1020_surname_mendeliangenetics_F13.rtf
BIOL 1020
Lab Assignment: Mendelian Genetics

Start by re-saving this file as follows: lab_surname_mendeliangenetics.rtf, substituting your own surname. Remember to convert to PDF after you have finished entering your answers and before submitting for grading.

Type your responses to the questions below where indicated. Remember to save your work frequently.

One-Gene Cross

1. Using the data available to you in this lab (i.e., the photograph of Cob 4), is it possible to directly observe the genotypes of the corn kernels? Explain. (1 mark)

RESPONSE:

PLEASE LEAVE THE SPACE BELOW EMPTY FOR TA COMMENTS

2. Based on the F1 generation results observed on Cob 4 and the information given about the parents, state an appropriate hypothesis about the genotype of the F1 (i.e., Cob 4) corn kernels. (1 mark)

RESPONSE:

PLEASE LEAVE THE SPACE BELOW EMPTY FOR TA COMMENTS

3. Use a Punnett square to generate a prediction about the observable results of your stated experiment if your stated hypothesis is true. Fill in the table below (you may not need to use all cells); if formatting is a problem, construct your table in another program, save it as an image file, and insert it into this document or upload it separately with your surname included in the filename. Below the table, state your prediction in the form of words or ratios. (1 mark)

PREDICTION:

PLEASE LEAVE THE SPACE BELOW EMPTY FOR TA COMMENTS

4. Enter your total number of Cob 1 kernels of each colour in the 'Observed Number' column of the table below. Use your prediction above and your collected data to calculate the 'Expected Number'. Complete the table based on the calculations indicated in the column titles. (3 marks)

Phenotype (Class)	Observed Number (o)	Expected Number (e)	(o - e)	$(o - e)^2$	$\frac{(o - e)^2}{e}$
Purple	generation	generation	generation	generation	generation
Yellow	generation	generation	generation	generation	generation
TOTAL					X^2

5. What is the p-value you obtained from the data for Cob 1? (1 mark)

RESPONSE:

PLEASE LEAVE THE SPACE BELOW EMPTY FOR TA COMMENTS

6. Give an interpretation for this p-value. (1 mark)

RESPONSE:

PLEASE LEAVE THE SPACE BELOW EMPTY FOR TA COMMENTS

7. Should your hypothesis be rejected or not? (1 mark)

RESPONSE:

PLEASE LEAVE THE SPACE BELOW EMPTY FOR TA COMMENTS

Two-Gene Cross

7. Write a hypothesis about the genotypes of each of the parents of the offspring found on Cob 6. Note that there are several possible options, and that the two parents don't necessarily have to have the same genotype. (1 mark)

RESPONSE:

PLEASE LEAVE THE SPACE BELOW EMPTY FOR TA COMMENTS

8. Use a Punnett square to generate a prediction about the Cob 6 phenotypes if your stated hypothesis is true. Fill in the table below (you may not need to use all cells); if formatting is a problem, construct your table in another program, save it as an image file, and insert it into this document or upload it separately with your surname included in the filename. Below the table, state your prediction in the form of words or ratios. (1 mark)

PREDICTION:

PLEASE LEAVE THE SPACE BELOW EMPTY FOR TA COMMENTS

9. Enter your total number of Cob 6 kernels of each phenotype in the 'Observed Number' column of the table below. Use your prediction above and your collected data to calculate the 'Expected Number'. Complete the table based on the calculations indicated in the column titles. (4 marks)

Phenotype (Class)	**Observed Number (o)**	**Expected Number (e)**	**(o - e)**	**$(o - e)^2$**	**$\frac{(o - e)^2}{e}$**
purple, smooth					
purple, wrinkled					
yellow, smooth					
yellow, wrinkled					
TOTAL					**X^2**

10. What is the p-value you obtained from the data for Cob 6? (1 mark)

RESPONSE:

PLEASE LEAVE THE SPACE BELOW EMPTY FOR TA COMMENTS

11. Give an interpretation for this p-value. (1 mark)

RESPONSE:

PLEASE LEAVE THE SPACE BELOW EMPTY FOR TA COMMENTS

12. Should your hypothesis be rejected or not? (1 mark)

RESPONSE:

PLEASE LEAVE THE SPACE BELOW EMPTY FOR TA COMMENTS

Statisticsinintroductorybiology.pdf

STATISTICS IN INTRODUCTORY BIOLOGY

This supplement is excerpted with permission from the BIOL 1010 lab manual (Bishop et al., 2012). References to BIOL 1010 and BIOL 1011 also apply to BIOL 1020 and BIOL 1021, respectively.

Bishop T, Gass G, Van Dommelen J. 2012. Appendix E: Statistics in Introductory Biology. In: Biology 1010 Laboratory Manual. Halifax (NS): Dalhousie University.

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In virtually every published primary research article in science, the Results section will contain the results of a number of statistical tests performed on the data collected by the researchers. Scientists use statistics to demonstrate mathematically that their results (for example, that plants treated with Fertilizer A grew larger than plants treated with Fertilizer B) are meaningful. For example, a biologist might weigh the plants in the two groups and find that the average weights calculated for each group were different values. The researcher would not stop there, but would then want to find out whether that the difference observed between the two groups is a legitimate or significant one (Fertilizer A really does promote plant growth better than Fertilizer B), rather than just an accident of chance (that is, the plants chosen for measurement in treatment A just happened to be heavier than the plants chosen for measurement in treatment B, even though there was no real difference in weights caused by the fertilizer used). Another biologist might have used a hypothesis to generate a prediction of the frequency of a particular phenotype in the offspring of a cross between two plants. When he or she actually performs that cross by breeding the plants together, do the frequencies match what was predicted? If they don't match exactly, are they close enough, or do the expected and the observed differences differ significantly?

In this Appendix, you will learn the basic statistical techniques that you may need to use in your BIOL 1010 and 1011 laboratory activities. More advanced biology classes make use of more advanced statistical techniques, but many of these techniques are based on the same concepts you will use in your labs this year.

There are three sections to this Appendix:

I. Basic descriptive statistics: mean and standard deviation

II. Statistical tests: the chi-square test

III. Standard error and 95% confidence intervals

I. BASIC DESCRIPTIVE STATISTICS: MEAN AND STANDARD DEVIATION

When a group of measurements are taken, we often want to be able to characterize that group using descriptive statistics: for example, what was the middle or average weight of a plant in that group? How much did individual plants in that group tend to differ in weight from one another?

A common measure of the middle or average value used in biology is the mean. You have likely calculated means in secondary school math: the mean is found by adding up all of the observed values, then dividing by the number of observed values. The number of observations or data points is referred to as n. The Greek letter sigma (Σ) indicates that you should sum up whatever comes immediately after

Lab 5: Mendelian Genetics

Lab 5
Mendelian Genetics

Name:

Lab day:

Lab time:

Lab room:

TA:

LEARNING OBJECTIVES

By the end of this lab, you should be able to:

1. Explain the difference between phenotype and genotype.
2. Use the hypothesis-experiment-prediction (if/and/then) model and the Punnett square diagramming technique to write hypotheses and to generate predictions of phenotypic ratios in the offspring of one-gene and two-gene breeding experiments (crosses).
3. Use these predicted ratios to generate expected numbers of offspring showing each phenotype, and compare the expected numbers with the observed numbers of offspring of each phenotype using the chi-square statistical test.
4. Interpret the results of the chi-square test to determine whether or not your hypothesis should be rejected.
5. Reflect on the usefulness of your midterm studying strategies in preparation for the final exam.

PRE-LAB EXERCISES

Complete the pre-lab quiz on OWL between 8am Thurs-8am Monday before your lab day.

In preparation for this week's lab, read through the entire lab, then review figures 14.5 and 14.8 in your textbook and answer the following questions. There will be a short quiz held at some point during your lab this week; this quiz will require that you understand this week's concepts and techniques well enough to apply them to a new example, so make sure to arrive at lab well-prepared to use your genetics skills.

BIOL1020_surname_pancreaticenzymesI_F13.rtf
BIOL 1021
Lab Assignment: Pancreatic Enzymes and Diseases I

Start by re-saving this file as follows: lab_surname_pancreaticenzymesI.rtf, substituting your own surname. Remember to convert to PDF after you have finished entering your answers and before submitting for grading.

Type your responses to the questions below where indicated. Remember to save your work frequently.

Literature Packet and Questions

Download the literature packet from the assignment dropbox for this lab. Read the packet carefully, and more than once if required, making sure to ask questions of your TA or fellow students if you need help. This readings package is designed to be brief, but challenging for a beginning biology student. It will be the starting point for two lab assignments. You will also find it useful to review your textbook readings on animal digestion, particularly section 41.3. After you have read the packet carefully and reviewed your textbook readings, answer the questions below.

1. With reference to readings 1 and 2, explain our current understanding of what causes pancreatitis, making reference to the roles played by specific enzymes. (2 marks)

RESPONSE:

PLEASE LEAVE THE SPACE BELOW EMPTY FOR TA COMMENTS

2. Fill in the blank spaces in the table below with information about some of the key enzymes discussed in the articles. Some details that are not covered by the selected readings are provided for you. You will use this table as a reference for later sections of the assignment. (1 mark)

Enzyme Name	Enzyme Function	Name of Zymogen form	Location of Zymogen Synthesis	Activated By	Location of Activation
trypsin					
chymotrypsin					
phospholipase A2	lipase (digests lipids)	prophospholipase A2			
pancreatic secretory trypsin inhibitor (PSTI)					
enteropepsidase					

3. In what way is trypsin activation similar to pepsin activation (described on p. 885 of your textbook), and how does it differ? (1 mark)

RESPONSE:

PLEASE LEAVE THE SPACE BELOW EMPTY FOR TA COMMENTS

4. With reference to reading 3, explain our current understanding of what causes EPI in dogs. (2 marks)

RESPONSE:

PLEASE LEAVE THE SPACE BELOW EMPTY FOR TA COMMENTS

5. How is EPI treated in dogs and in humans? Based on what you have learned about enzymes and the process of chemical digestion, why does so little effective enzyme reach the small intestine? (2 marks)

RESPONSE:

PLEASE LEAVE THE SPACE BELOW EMPTY FOR TA COMMENTS

Make A Diagram

6. Draw a labelled diagram showing the process of trypsin activation. Don't forget to indicate the location where each step takes place, and the role of the following proteins: trypsinogen, trypsin, PSTI, and enteropeptidase. In Part II of the lab, you will be expanding this diagram and creating a second, related diagram; at this stage, your goal is to create a diagram that makes the trypsin activation process clear to you and to anyone reading your assignment. Making diagrams can be a very effective study tool, too, so the more work you put into your diagram at this stage, the more you're likely to benefit. (4 marks)

You can draw your diagram on paper and then scan it, or use an application like DrawFree to draw freehand, or use PowerPoint or a free web-based application like Diagramly to make a diagram using available shapes. Insert the diagram into the space below, or submit as a separate .jpg file along with your assignment. Incorporate your surname into the filename for the image if you submit it separately.

INSERT DIAGRAM HERE:

PLEASE LEAVE THE SPACE BELOW EMPTY FOR TA COMMENTS

Generate A Question and Design An Experiment

Now that you are familiar with the functions and relationships of some key digestive enzymes produced by the pancreas, you can use your understanding to develop a simple experiment to investigate some aspect of this system. Below you will see a list of possible enzymes to use in your study (review the table in question 2 to remind yourself about the function(s) of each enzyme), as well as two food substrates, and two techniques for measuring enzyme action indirectly. An interesting aspect of studying enzymes is that it is usually not possible to directly observe them performing their functions – each enzyme is just too small. Because of this, biologists need to use indirect methods of observing enzyme action, by using techniques that make the enzymes' effects measurable somehow – often as a visible colour change. These techniques are often simple, but ingenious. In your experimental design, you will need to plan for the use of these techniques in order to produce measurable results. Another interesting aspect of studying enzymes is that their action can be studied in vitro – that is, in test tubes rather than within organisms.

<u>The Toolkit</u>

available samples of enzymes
(assume that all enzymes are at appropriate concentration in liquid buffer)

- trypsin
- trypsinogen
- chymotrypsin
- chymotrypsinogen
- enteropeptidase
- prophospholipase A2
- phospholipase A2
- PSTI

available non-enzyme substrates

- whole milk (source of lipids), in liquid form
- gelatin (source of collagen protein), bound to developed film

available detection techniques

- Phenol red pH indicator technique for detecting lipid digestion rate: A colour-changing pH detector, phenol red, is added to the test tube with a source of lipids and a lipase. As the lipase digests lipids, breaking the lipids down into fatty acids, the solution gradually becomes more acidic and the indicator gradually turns from pink to yellow. The faster the digestion happens, the faster the colour change happens. (Bishop *et al.* 2012)
- Developed film strip assay technique for detecting gelatin protein digestion rate: gelatin proteins keep silver grains adhered to strips of developed photographic film, giving the film a dark grey colour. The developed film strips are immersed in a solution containing the protease. As the protein is digested by the protease, it can no longer attach the silver grains to the film, so the silver grains fall off into solution and the film strip becomes colourless. The faster the gelatin is digested,

the faster the film becomes colourless. (Glider and Hargrove 2002)

How to Proceed

A question is the starting point for a scientific study. When you have asked a question, then you can propose a hypothesis as a tentative answer to this question, devise an experiment to test this hypothesis, and make predictions about what results you would expect to observe in this experiment if your hypothesis were correct. In this portion of the assignment, you will generate a question and design and experiment.

7. What is your question? Think of some aspect of the reading that you found particularly interesting and would like to explore further using a selection of the available materials listed above under "The Toolkit". (1 mark)

RESPONSE:

PLEASE LEAVE THE SPACE BELOW EMPTY FOR TA COMMENTS

8. Now, design your experiment. It will be useful to review section 1.3 in your textbook, especially the information on controls, before tackling this part of the assignment. When you downloaded this assignment document and the readings package, you should also have downloaded a document called "Controlled Experiments"; read this over as well for a bit more information on how and why we use controls in biological experiments. Your TA will review your experimental design, and you will have the opportunity to revise it if necessary in Part II of the lab. (6 marks)

a. Which materials and techniques from the toolkit list will you use in your experiment? What procedure will you follow?

b. What data will you collect – that is, what will you measure or record when the experiment is running? At what points during the experiment will you collect data?

c. What control or controls will you set up, to make sure that the experiment is testing the variables described in your hypothesis, and that any effect that you see is due to the variables you're interested in, rather than being due to some other variable?

RESPONSE:

PLEASE LEAVE THE SPACE BELOW EMPTY FOR TA COMMENTS

Controlled Experiments S13.pdf

Designing Controlled Experiments

You have a scientific question, and you've proposed a hypothesis as a tentative answer to that question. Now, you've decided to design an experiment that will help you test that hypothesis. This is actually an interesting moment, because starting work on this next step will tell you something about your hypothesis and something about your experiment.

If the hypothesis is a good one – and this is a different question from whether the hypothesis turns out to be a keeper or not – then you should be able to design an experiment such that your hypothesis will give rise to a specific prediction of the outcome of that experiment. If you run the experiment and that outcome happens, then you can hang on to the hypothesis and continue your work along these lines, probably by exploring related hypotheses or designing different but related experiments to explore further. If you run the experiment and some other outcome happens, then you get rid of that particular hypothesis and consider what you've learned from the experiment and what to do next. If you've got a hypothesis and you just can't think of any experiment that could test a prediction arising from that hypothesis, one possibility is that you need to take another look at your hypothesis and make sure that it is in fact a specific answer to a specific question. (Another possibility is that you just haven't come up with an appropriate experiment yet – designing good experiments takes creativity and ingenuity, and of course lots of practice!)

If the experiment is a good one, then at the end of the experiment you should feel confident that the outcome of the experiment has given a clear indication of what to do about your hypothesis. Along with feeling confident yourself about the outcome and the decision to keep or discard your hypothesis, if the experiment is a good one you should feel confident that when you tell your colleagues about what you did, they will also feel confident that the experiment you performed was a reasonable test of that hypothesis. Neither you nor your colleagues should have lingering doubts about whether the decision you made about your hypothesis was legitimate based on the experiment you performed.

Where might these lingering doubts come from? Well, chances are, your hypothesis proposes the effect of one thing (let's call it X, for now) on some other thing (let's call it Y, for now). We might represent the relationship that you're exploring like this:

In the experiment that you'll design, X is your **independent variable** – the variable that you manipulate in the experiment. In this same experiment, Y is your **dependent variable**: you will be measuring Y, or some measurable aspect of Y, to determine if and how it changes in response to changes in X. But X probably isn't the only thing out there that can have an effect on Y. This might make more sense as a concrete example. If you are working on a question about how the abundance of a particular enzyme is controlled in cells, you might hypothesize that the amount of a particular sugar present in the cells (X) is related to the abundance of the enzyme (Y) such that as the concentration of

Pancreatic enzymes and diseases readings.pdf

Pancreatic Enzymes and Diseases readings

1. **from MayoClinic.com, a credible online medical resource**

http://www.mayoclinic.com/health/pancreatitis/DS00371/DSECTION=causes

Causes

By Mayo Clinic staff

What happens in pancreatitis
Pancreatitis occurs when digestive enzymes produced in your pancreas become activated while inside the pancreas, causing damage to the organ.

Pancreatitis caused by gallstones

During normal digestion, the inactivated pancreatic enzymes move through ducts in your pancreas and travel to the small intestine, where the enzymes become activated and help with digestion. In pancreatitis, the enzymes become activated while still in the pancreas. This causes the enzymes to irritate the cells of your pancreas, causing inflammation and the signs and symptoms associated with pancreatitis.

With repeated bouts of acute pancreatitis, damage to the pancreas can occur and lead to chronic pancreatitis. Scar tissue may form in the pancreas, causing loss of function. A poorly functioning pancreas can cause digestive problems and diabetes.

Pancreatitis has many causes
A number of causes have been identified for acute pancreatitis and chronic pancreatitis, including:

- [illegible]
- Gallstones
- Abdominal surgery
- [illegible]
- Cigarette smoking
- Cystic fibrosis
- Endoscopic retrograde cholangiopancreatography (ERCP), which used to treat gallstones
- Family history of pancreatitis
- High calcium levels in the blood (hypercalcemia)
- High levels of parathyroid hormone in the blood (hyperparathyroidism)
- High triglyceride levels in the blood (hypertriglyceridemia)
- Infection
- Injury to the abdomen
- Pancreatic cancer

BIOL1021_surname_pancreaticenzymesII_F13.rtf

BIOL 1021
Lab Assignment: Pancreatic Enzymes and Diseases II

Start by re-saving this file as follows: lab_surname_pancreaticenzymesII.rtf, substituting your own surname. Remember to convert to PDF after you have finished entering your answers and before submitting for grading.

Type your responses to the questions below where indicated. Remember to save your work frequently.

Review Your Graded Part I Assignment

Each task in this assignment builds on the work that you submitted in Part I. Before beginning, you will need to carefully review your Part I assignment, and any comments that your TA made on your work. A table describing the two parts of the assignment is given below for your reference.

Part 1	1. Read the literature packet and answer questions to establish your understanding of the role of enzymes in digestion generally, and the roles and interactions of pancreatic enzymes in particular. 2. Develop a diagram illustrating the process of trypsin activation. 3. Use your understanding from the readings packet to design a simple experiment to answer a research question about pancreatic enzyme action.
Part 2	1. Based on Part I and your TA's feedback, use your knowledge of digestive enzymes to address some more complex questions. 2. Revise your diagram from Part I as needed, and expand the diagram to include two more digestive enzymes. Create a second diagram showing our current understanding of pancreatitis, with the goal of using these two diagrams to explain to a friend the function and malfunction of the pancreatic digestive enzyme system. 3. Revise your experimental design, and write predictions for the observed results.

The Literature Packet and Questions

1. Using what you have learned so far in BIOL 1021 about enzymes and digestion, evaluate this claim: "Raw foods contain all of the enzymes needed for these foods to be digested. Cooking foods destroys these enzymes, so if you eat cooked foods you should take digestive enzyme replacement pills to supply these enzymes to your body." (4 marks)

RESPONSE:

PLEASE LEAVE THE SPACE BELOW EMPTY FOR TA COMMENTS

2. Animals ingest their food, and use pepsin, trypsin and other digestive proteases to break down the proteins in their food into shorter peptides and ultimately into amino acids, which the animal can then absorb and incorporate into newly-synthesized proteins of its own. Proteases are also found in plants, despite the fact that plants do not ingest their food. For example, you may have noticed the warning on Jell-O boxes that the gelatin will not set if pineapple or kiwi are present; this is because these fruits contain relatively large amounts of proteases, which digest the proteins in gelatin.

Clearly, proteases perform a number of functions in organisms beyond breaking down proteins in ingested food. In the space below, describe at least two other roles played by proteases in organisms. You will need to do some searching online to find this information; make sure to stick to credible sources, and include CSE-style citations for the sources used in your answer. (3 marks)

RESPONSE:

PLEASE LEAVE THE SPACE BELOW EMPTY FOR TA COMMENTS

Make A Diagram

3. In Part I of your assignment, you created a diagram showing the activation of trypsin. In the space below, begin with your trypsin diagram (modified as necessary, based on your TA's comments on the Part I assignment), then expand the system illustrated in your diagram to include the activation of chymotrypsin and phospholipase A2. Make sure to check the enzymes table in your Part I assignment, and correct it if necessary before using the information to expand your diagram. (4 marks)

Incorporate your surname into the filename for the image if you submit it separately.

INSERT DIAGRAM HERE:

PLEASE LEAVE THE SPACE BELOW EMPTY FOR TA COMMENTS

4. Based on your previous diagram, your readings 1 and 2, and the feedback you received on your Part I assignment, make a second diagram showing our current understanding of the role of digestive enzymes in pancreatitis.

When you have finished this section of the assignment, you will have two diagrams. One shows the normal function of digestive enzymes produced in the pancreas, and the other shows what happens in a situation where the system malfunctions. You can use these diagrams in your own studying; they are also a great tool for explaining this system to someone else. Try them out! Most people are very interested to learn about digestion and disease, and explaining a system or concept to someone else is one of the best ways to solidify (and test!) your own understanding of the subject.
(4 marks)

INSERT DIAGRAM HERE:

PLEASE LEAVE THE SPACE BELOW EMPTY FOR TA COMMENTS

Revise Your Experiment and Make Predictions

5. In Part I of the assignment, you chose a question and designed an experiment. Now that you have read your TA's feedback on Part I, and had some more time to consider your question and experimental design, you may wish to revise some aspects of this plan. In the box below, describe your revisions in detail. If you are using the same question and/or experimental design that you proposed in Part I, restate this information in the space below, and indicate that this information matches your Part I submission. (2 marks)

RESPONSE:

PLEASE LEAVE THE SPACE BELOW EMPTY FOR TA COMMENTS

6. You will need to make predictions for the outcome of your experiment, based on what you think the answer to your question will be. The answer to your question is your hypothesis. Begin by stating your hypothesis. (1 mark)

RESPONSE:

PLEASE LEAVE THE SPACE BELOW EMPTY FOR TA COMMENTS

7. Your predictions will be consistent with your hypothesis. However, while a hypothesis is a straightforward answer to a scientific question, it is important that the predictions generated from this hypothesis be stated in observable terms. For example, if the enzyme itself is not actually visible, but you are doing something to visualize the process indirectly, then your prediction needs to be in terms of what you will actually see or measure directly. Review Part I of your assignment to remind yourself what exactly you will be measuring and observing.

Predictions are sometimes presented in an if/and/then format: IF the hypothesis is correct, AND the experiment that you just described is carried out, THEN what do you expect to observe? In the space below, complete the THEN portion of this statement for your hypothesis and experiment by stating what you predict would be directly observed if the experiment were carried out. (2 marks)

RESPONSE:

PLEASE LEAVE THE SPACE BELOW EMPTY FOR TA COMMENTS

References

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