BIOSTATISTICS (BIO 29): WINTER 2020

STAFF

Professor – Kathryn L. Cottingham, Ph.D.

Office location: Life Sciences Center 124. Office phone: 603-646-0216

Student hours: Tuesdays 2:10 – 3:10 pm, LSC 1st floor atrium
Also available after most class meetings, and in the classroom during T x-hours if no class

Email availability: Please send all class-related emails to my regular Dartmouth email. I typically do not read email first thing in the morning and do not leave my email open while working on other tasks, so please don't expect instant responses. I will respond to all Bio 29-related emails received by 6:00 pm before I sign off for the evening.

Graduate Teaching Assistants

Luke Fannin, student hours in Silsby 408A, Wednesdays 9-10 am and by appointment

Kaitlin McDonald, student hours in LSC 020, by appointment

COURSE OBJECTIVES

The primary goal of this course is to develop a strong foundation in exploratory data analysis and parametric biostatistics, with an emphasis on real data and authentic applications. By the end of the term, students will:

1. Be able to explain why statistics is interesting and useful in biology, using concrete examples
2. Understand and succinctly explain the reasoning behind standard methods of parametric statistical inference, especially confidence intervals and significance tests
3. Use statistical vocabulary accurately and with confidence
4. Demonstrate proficiency in many of the skills used by practicing statisticians, including:
   - Preparing, interpreting, and captioning graphical and tabular summaries of data
   - Calculating and interpreting summary statistics for data
   - Designing data collection procedures that produce clear answers to specific questions
   - Conducting one and two-sample *t*-procedures, simple linear regressions, and one-way analyses of variance
   - Drawing conclusions from data and (when appropriate) inferential statistics calculated from data
   - Presenting these conclusions in written format and in short oral presentations using the language of statistics
   - Providing constructive critiques of scientific graphics and statistical analyses from the peer-reviewed literature and from classmates
   - Working with the statistical software JMP®
   - Collaborating with other scientists on data collection, analysis, and presentation of results

No prior experience with statistics is needed, but we expect you to be familiar with the procedures used to collect data by at least one subfield within biology, comparable to the material covered in a Foundations course, Bio 12-16.

COURSE PHILOSOPHY

I seek to meet these objectives using a 'flipped' classroom with a supplemental weekly laboratory that gets you ready for the in-class work during our course meetings. The course requirements place a strong emphasis on structured problem-solving during class and lab, in addition to individual work outside of class. I will spend some of our class time lecturing, but we will also spend time in class actually doing statistics and practicing describing your findings in an environment where you can ask questions and get help right away.

To create the time to do those hands-on activities during scheduled class time, each of you will need to prepare for class meetings by completing the requested activities *before* class/lab: this may include reading in our textbook, watching instructor-prepared and publicly available videos, getting familiar with our statistical software JMP, and/or taking a quiz or preparing a short assignment documenting your work.

Throughout the term, students will demonstrate their learning through multiple pathways: their out-of-class preparatory activities, individual quizzes during course meetings, during-class and during-lab group activities, and individual out-of-class assignments. The full assessment strategy is spelled out in more detail beginning on page 6. I welcome questions from students at course meetings, during student hours and appointments, and via email – please do ask when you want to know something!

Note that Canvas will help you keep track of the specific deadlines; there are lots of them and you will need to be organized and pro-active in order to keep up.

COURSE MEETINGS

Statistics is a cumulative subject best learned by doing. Thus, your prompt attendance is expected at <u>all</u> course meetings (lectures, labs and scheduled x-hours), and participation at these sessions is an important component of your grade in this course. If you find that you need to miss a class due to a previously scheduled activity, please alert Professor Cottingham well in advance, so that appropriate arrangements can be made for you to catch up on any missed material. Making up during-class assignments due to unplanned conflicts such as illness will be handled on a case-by-case basis – please contact Prof. Cottingham immediately if you have missed a class so we can make appropriate arrangements.

Lectures: Mondays, Wednesdays, and Fridays, 12:50-1:55 pm, Life Sciences Center (LSC) 200.

Laboratories: Mondays, 3-5 pm and Tuesdays, 8-10 am, LSC 104. If you cannot make either of those times, please contact Professor Cottingham immediately.

X-hours: Tuesdays, 1:20-2:10 pm, LSC 200. We will have important activities and discussions at some x-hours, see online calendar for details. Otherwise, x-hours will revert to "office" hours.

Classroom Policy: We expect you to use your laptop during appropriate times at our course meetings. However, multi-tasking that keeps you from participating fully in whole-class or small-group activities (such as checking e-mail, the news, or social media; making online purchases) is strictly prohibited. If we notice you doing this, we will gently remind you of this policy. Repeated reminders will reduce the course participation grade. Keep in mind that the TAs sit in the back of the classroom and can see what you're doing! ☺

RESPONSIBILITIES & EXPECTATIONS

I expect that students in this course will

1. Attend course meetings and be on time for those meetings
2. When possible, alert the professor *in advance* to potential issues with attendance or timely completion of assignments
3. Come to each course meeting having done the requested preparatory work and ready to engage with the material, including demonstrating learning in a short quiz
4. Actively participate at course meetings by taking notes during the lecture portion of each class and by contributing actively to your group's deliberations and analyses
5. Demonstrate understanding of course material in group assignments at class and lab
6. Demonstrate understanding of course material in individual out-of-class assignments
7. Keep track of course activities and announcements via our Canvas site
8. Seek help from the teaching staff when needed through questions at class, student hours, appointments, and/or email

Students can expect Prof. Cottingham to

1. Be organized and well-prepared throughout the course
2. Be knowledgeable about the course material
3. Stimulate interest in the course material
4. Explain course material clearly and efficiently
5. Answer student questions thoroughly
6. Be available for, and amenable to, consultations regarding lectures, assignments, and other student concerns
7. Use methods of evaluation that provide a representative test of student knowledge and understanding of the course material
8. Grade student work fairly and return it promptly
9. Be receptive to student requests for accommodations and suggestions for improvement

Students can expect the Teaching Assistants (TAs) to

1. Master the material presented at course meetings and be able to explain it clearly
2. Be prepared to lead the weekly laboratory sessions and answer questions that come up at lab
3. Effectively facilitate small-group activities at lecture, lab, and x-hours
4. Grade student work fairly and return it promptly
5. Serve as a liaison between students and the professor

STUDENT NEEDS

Student Accessibility and Accommodations

Students with disabilities who may need disability-related academic adjustments and services for this course are encouraged to see me privately as early in the term as possible. Students requiring disability-related academic adjustments and services must consult the Student Accessibility Services office in Carson Hall 125 or by phone: 646-9900 or email: Student.Accessibility.Services@Dartmouth.edu.

Once SAS has authorized services, students must show the originally signed SAS Services and Consent Form and/or a letter on SAS letterhead to me. As a first step, if you have questions about whether you qualify to receive academic adjustments and services, you should contact the SAS office. All inquiries and discussions will remain confidential.

Textbook Costs, Printing, and Financial Difficulty
If you encounter financial challenges related to this class, please let me know.

Religious Observances
Some students may wish to take part in religious observances that occur during this academic term. If you have a religious observance that conflicts with your participation in the course, please meet with me before the end of the second week of the term to discuss appropriate accommodations.

Mental Health & Wellness
The academic environment at Dartmouth is challenging, our terms are intensive, and classes are not the only demanding part of your life. There are a number of resources available to you on campus to support your wellness, including:
your undergraduate dean (http://www.dartmouth.edu/~upperde/),
Counseling and Human Development (http://www.dartmouth.edu/~chd/),
and the Student Wellness Center (http://www.dartmouth.edu/~healthed/).

I encourage you to use these resources to take care of yourself throughout the term, and to come speak to me if you experience any difficulties

Title IX
At Dartmouth, we value integrity, responsibility, and respect for the rights and interests of others, all central to our Principles of Community. We are dedicated to establishing and maintaining a safe and inclusive campus where all have equal access to the educational and employment opportunities Dartmouth offers. We strive to promote an environment of sexual respect, safety, and well-being. In its policies and standards, Dartmouth demonstrates unequivocally that sexual assault, gender-based harassment, domestic violence, dating violence, and stalking are not tolerated in our community.

The Sexual Respect Website (https://sexual-respect.dartmouth.edu) at Dartmouth provides a wealth of information on your rights with regard to sexual respect and resources that are available to all in our community.

Please note that, as a faculty member, I am obligated to share disclosures regarding conduct under Title IX with Dartmouth's Title IX Coordinator. Confidential resources are also available, and include licensed medical or counseling professionals (e.g., a licensed psychologist), staff members of organizations recognized as rape crisis centers under state law (such as WISE), and ordained clergy (see https://dartgo.org/titleix_resources).

Should you have any questions, please feel free to contact Dartmouth's Title IX Coordinator or the Deputy Title IX Coordinator for the Guarini School. Their contact information can be found on the sexual respect website at: https://sexual-respect.dartmouth.edu.

A Note on Help

Statistics is a cumulative subject best learned by doing. It is difficult to catch up if you fall behind during the early weeks of the term. Do not be afraid to seek help early and often! Help with the course material can be obtained from the teaching staff during our posted student hours and by appointment. Note that we strongly encourage you to work in groups during class and on the preparatory assignments, since much can be learned from comparing how different people address the same statistical problem. However, you must work independently on the designated individual out-of-class assignments (see also **HONOR PRINCIPLE**, page 9).

COURSE MATERIALS

- Canvas. This course will use the Canvas platform extensively both to disseminate materials and to receive completed assignments. All faculty-generated materials will be made available through Canvas, including handouts for lectures, pre-recorded videos, labs, preparatory and during-class assignments; datasets; handwritten notes from class lectures; and templates for during-class or out-of-class assignments. Please note that we will typically work directly from handouts when in lecture or lab mode and plan to bring copies of these handouts to class for you; your printing needs should be minimal.

- Text: The Practice of Statistics in the Life Sciences, ANY edition, by B. Baldi and D.S. Moore. W.H. Freeman and Company, New York. This text – "PSLS" – presents quantitative analysis in a life sciences context, emphasizing the use of real data and statistical thinking. All examples and exercises are drawn from diverse areas of biology, including physiology, brain and behavior, epidemiology, health and medicine, nutrition, ecology, and microbiology. You can use a hard copy of the early editions (often available for low cost) or arrange to use the text electronically as an eBook (typically much higher cost, but does provide access to additional resources).

- JMP (pronounced "Jump") Statistical Software. All analyses, especially during class periods, will need to be completed using the user-friendly package JMP. There is a campus-wide site license for this software – Mac users should start here: https://services.dartmouth.edu/TDClient/1806/Portal/KB/ArticleDet?ID=64613 and PC users should start here: https://services.dartmouth.edu/TDClient/1806/Portal/KB/ArticleDet?ID=64626

  We expect you to have JMP loaded and working on your computer before the first laboratory session. Please contact Professor Cottingham if you have any questions or concerns about this.

- Supplemental texts, readings, and humorous diversions will be available via external links from Canvas. These materials will provide more detail about topics covered in lecture or lab, provide examples of applications of statistics to biological questions, review recent discussions of statistics in the literature, and make you laugh (or groan). Some of these materials will be referenced on lecture handouts and assignments as appropriate.

COURSE REQUIREMENTS & GRADING

This is an immersive experience in biostatistics. We are asking you to work steadily throughout the term, rather than episodically in preparation for exams or large problem sets. As such, your performance will be assessed frequently through the preparatory assignments and pop quizzes of your in-class readiness, group work during most class meetings and the lab sessions, weekly individual out-of-class assignments (IOCA), and class participation. Each of these methods of assessment is explained in more detail below.

Note: late assignments will generally not be accepted except under extraordinary circumstances discussed with Prof. Cottingham *before* the assignment is due. Links to assignments, especially places to submit written work via Canvas, may 'disappear' shortly after the due date/time. If you know you have a bad week coming, make arrangements for a delayed due date in advance.

(1) Out-of-class Preparation (10% of final grade)

To maximize productivity during our in-class time, you will need to come to most class meetings having completed some sort of preparatory assignment. As noted above, we're going to spend much of our class time on problem solving and discussions. In order for this to work, each student will need to prepare for course meetings in several different ways: reading appropriate chapters in the textbook, watching videos, exploring JMP via guided software prep exercises, and more. Plan on spending ~2-3 hours getting ready for each course meeting, in addition to working on your weekly individual out-of-class assignments.

- You should read the designated chapters of the textbook, but we will not track reading directly. Instead, we will expect you to be familiar with the material in the readings and to incorporate it into your quiz answers, during-class group work, and individual out-of-class assignments; key points will be highlighted in the videos and at lecture.
- For most topics, there will be pre-recorded lectures that walk through the key material, typically lasting anywhere from 15-45 minutes per class period. Early in the term, we will do spot checks on whether students have watched the videos. If it looks like students aren't watching the videos before coming to class, we will give the videos point values and track video watching as part of this component of the course.
- For a few topics, there may be post-class videos that wrap up a during-class activity that ran long. This is our first time doing Bio 29 as a flipped "12" instead of a "10A", and timing may be off for some activities despite our best efforts to right-size the activities.
- In a few units, you may be asked to turn in 'proof of work' assignments. For example, during the probability unit, you may be asked to complete problems from the textbook, or where lecture and lab don't come together smoothly, you may have software preparation activities to build your JMP skills for hands-on group work during lab and class. Grading of these 'proof of work' activities will use a discrete scale out of 4 points: A = exceeds expectations (4.0); AB = meets expectations (3.5); B = needs some improvement (3.0); BC = needs considerable improvement (2.5); C =inadequate (2.0); and E = missing (0.0). Note that these prep assignments may be done in groups if you wish; see the individual assignments for details on how to identify group members and submit the assignment to the teaching staff.

We will talk about the prep assignments more at class, but please ask if you have any questions in the meantime.

(2) In-class Readiness: Quizzes (10% of final grade)

At least once a week, you will be asked to complete short, in-class quizzes that test whether you're (a) at class or lab on time, (b) keeping up with the material, and (c) understanding it. Depending on the quiz, you will have 5-15 minutes to write down or type your answer to the question(s). For example, you may be asked to define a concept, interpret statistical output, criticize an analysis, or reflect on recent class material. Sometimes the quizzes will be graded; other times, we will simply use them to take attendance and assess how well the class as a whole understands current material. Ungraded quizzes will be scored as 0's and 1's: 1 if the quiz was completed and 0 if it wasn't. Graded quizzes will use point values, typically 2-4 points per quiz. We will typically discuss each quiz immediately afterward to help clarify understanding and answer any questions you have about the material.

(3) During-Class Group Assignments (DCA, 35% of final grade)

During-class work (which will take place both at lecture and lab) will include a variety of activities, including generating figures, tables and well-written captions; solving problems either with pen and paper or statistical software; designing an observational study or experiment; interpreting results of analyses; outlining a report on your findings; and constructively critiquing work by others. Many days, we will take advantage of the computer monitors available around our classroom to conduct analyses in groups of ~2-3 students, which will typically then be submitted electronically by the whole group. Plan to bring your laptop to each class to ensure that you are ready for anything!

Many, but not all, activities will result in submitted assignments. During-lab assignments will be graded by the TA's on a numeric scale following a rubric, with total point values roughly approximating the "degree of difficulty" of the activity. Graded assignments will be returned no later than the Friday lectures.

During-lecture assignments will also be graded within a few days, but will likely use a more coarse scale similar to that used for quizzes: A = exceeds expectations (~90-95%); AB = meets expectations (~85%); B = needs some improvement (~75-80%); BC = needs considerable improvement (~65-70%); C =inadequate (~50%); and E = missing (0%). Assignments that adequately answer the questions but that don't stand out as exceptional will be scored as AB's. Exceptional answers will receive A's, typically for unusually thorough or innovative answers. Assignments that are missing key elements or need work will receive B's or lower, with successively lower scores given to assignments that are deficient in multiple areas.

Much of the time, we will discuss these assignments either at the end of the same class or once they have been graded, so that you know what the right answers are and what the best papers look like. During grading, the teaching staff will provide comments and suggestions on your work, so that you know what was done well and what could use more work; for some assignments, you will also have access to what others submitted. Overall, we expect that careful work during lab and lecture, together with close attention to comments from the teaching staff and subsequent discussions of the best assignments, will result in better performance on the individual written assignments.

The during-class assignments will typically follow one of two temporal patterns: (1) started during class or lab by groups of students and then polished up and reflected upon outside of class by individuals as part of the individual out-of-class assignments (see below), or (2) started by individuals before class as part of their preparatory work and then polished by groups during class.

NOTE: All during-class assignments will be a group effort: each team of students will turn in one copy of the assignment, and all will receive the same score. If you are uncomfortable with this policy, please contact Professor Cottingham as soon as possible to discuss your concerns.

(4) Individual out-of-class assignments (IOCA, 40% of final grade)

To assess individual progress towards meeting the course goals, students will submit an independent assignment each week that builds on the group work done during class and reflects on learning and contributions during the previous week and across the entire term to date. These assignments will be graded on a numeric basis, typically from a rubric. Examples of past rubrics will be included with the assignments, though these are provided as guidelines *only*.

The IOCA typically (but not always) will be due on Tuesdays at 11:59 pm. They are intended to take ~2-4 hours, and will be open-book, meaning that you may consult any text or publicly available online resource you like in preparing your answers, including our Canvas site where during-class assignment answers from other groups may be posted. You may not, however, access any private material that is not available to the whole class; for example, you may not use a previous student's notes or graded assignments.

You **must** complete each individual out-of-class assignment completely independently – **you may not communicate with anyone except Professor Cottingham about the IOCAs.** For example, you cannot ask questions of the TAs and you cannot talk to other students or faculty (past, present, or future). See **HONOR PRINCIPLE**, page 9.

If you have a scheduling conflict and need an adjustment to the stated deadline for an IOCA, please discuss this with the professor by phone or in person well in advance. Accommodations are nearly always possible if you plan ahead by at least a few days.

(5) Participation (5% of final grade)

We will separate class participation into three components:

- Attendance, timeliness, and politeness, as judged by the student and the teaching staff.
- Engagement in class activities, as judged by the student and the teaching staff
- Being a good "team player" for group work, as judged by the student and their classmates.

Participation in each of these areas will be evaluated separately on a numeric scale, then scores will be summed. Detailed instructions on self-evaluation and peer-evaluation will be provided towards the end of the term.

General Hints

Assignments will typically be evaluated both in terms of their statistical merit and their presentation. Read the instructions carefully and ask if you have any questions.

I expect you to use college-level writing. Grammar, style, and spelling will count, so take the time to write complete sentences when they are requested, to proofread each answer, and to collate your work so as to make it easy to grade.

Be sure to follow instructions – especially regarding file types and page lengths – carefully. I am a stickler for details!

Final Grade Calculation

Your final grade in the course will be based on your performance on an absolute scale; grade distributions will be similar to other intermediate-level courses in biology. We will use the online grade book in Canvas to keep track of your scores on quizzes, during-class group assignments, and individual out-of-class assignments. Together, these grades will provide you with some information about how you are doing relative to your peers on the different types of assignments. However, please *do not* pay any attention to Canvas's scoring of your cumulative performance – we do not bother to assign the weightings to individual assignments, just the final scores in each of the areas of assessment. Also, please do not assume that just because you're at/near the median grade for individual assignments, you are also near the median grade overall – there are lots of scores and many factors going into grade calculations.

Finally, just to set reasonable expectations, the long-term median for this course has fluctuated between a B and a B+ depending on enrollment and NROs, consistent with departmental targets for intermediate-level courses.

If you want to know where you stand in the course at any point, talk to me. I typically do a download and quick look at totals every week or two and can show you where you're sitting in the distributions for each component quite easily using JMP.

HONOR PRINCIPLE

Honesty is the foundation of the academic pursuit of knowledge. In recognition of this, the faculty will not overlook any violations of the Academic Honor Principle. Indeed, the Faculty Handbook of Dartmouth College states explicitly that I am obligated to report potential violations of the Academic Honor Principle to the Dartmouth College Committee on Standards.

The Dartmouth Honor Principle applies to all work you submit for a grade in this course. All work you do for assignments designated as work to be done by an individual must be your own, although they will typically build on the during-class group activities. Similarly, during-class activities turned in by groups of students working together should represent the work of that team, as guided by the teaching staff.

As noted above, the individual assignments are open book to the extent that any information available to the whole class – via the textbook, Canvas, or the Web – may be accessed. However, you may not access private materials not available to everyone, including materials from past offerings of this course, and you may not talk to anyone about the individual assignments except Professor Cottingham.

Any questions? Contact Prof. Cottingham via email or in person.